

# SCIENCE

NEW SERIES  
VOL. 75, No. 1931

FRIDAY, JANUARY 1, 1932

SUBSCRIPTION, \$6.00  
SINGLE COPIES, 0.15

## NEW TEXT-BOOKS

### GRAVES' FEMALE SEX HORMONOLOGY

This is the first book to give a complete résumé of all the important literature on this subject. Dr. Graves begins his review back in the early literature and then rapidly comes to recent advances. He brings together and clarifies in clinical terms a great amount of material hitherto scattered in many journals throughout the world.

By **William P. Graves, M.D.**, Professor of Gynecology, Harvard Medical School. Octavo of 131 pages, illustrated. Cloth, \$3.50 net.

### BOMAR'S HOMEMAKING

Homemaking is set up as a profession. The author gives the student a broad and inspiring view of family life, its relation to community life, the development of the home, social and civil influences, planning the house, system in household routine, health building, the prevention of disease, the care of the child.

By **Willie Melmuth Bomar, Ph.D.**, Professor and Head of the Department of Home Economics, Kansas State Teachers College, Pittsburg, Kansas. 12mo of 241 pages, illustrated. Cloth, \$2.00 net.

### BOGERT'S NUTRITION and PHYSICAL FITNESS

The author's clear, non-technical language brings out impressively the facts of nutrition. Then, with the facts thoroughly grasped, the student is shown how to utilize his new knowledge in the prevention of illness and the promotion of the highest degree of physical fitness. Dr. Bogert's experience as a writer and as a worker in the fields of home economics, nutrition, physiology, chemistry, and medicine have equipped her especially well to present this new textbook.

By **L. Jean Bogert, Ph.D.**, formerly Instructor in Medicine, University of Chicago. 12mo of 540 pages, illustrated. Cloth, \$3.00 net.

### SELBERT'S CHILD HEALTH

Mrs. Selbert's new work meets a very definite need for a text-book on this subject. Its contents and the practical form of the presentation are the outgrowth of the author's successful work in teaching the subject to classes in Child Care and Adult Education. In language of good clarity, avoiding difficult technical terms, she sets down each practical procedure in *terms of practice*.

By **Mrs. Norma Selbert, R.N., B.S., M.A.**, College of Medicine of the Ohio State University. 16mo of 261 pages, illustrated. Cloth, \$1.60 net.

.....SIGN AND MAIL THIS ORDER FORM TODAY.....

**W. B. SAUNDERS COMPANY, W. Washington Square, Philadelphia**

Please send me the books checked (✓) and charge to my account:

* Bogert's Nutrition & Physical Fitness .....	\$3.00 net.	* Graves' Female Sex Hormonology.....	\$3.50 net.
* Bomar's Homemaking .....	2.00 net.	* Selbert's Care of the Child .....	1.60 net.

NAME ..... ADDRESS .....

\* These and any books gladly sent for consideration as texts

# DARE'S HAEMOGLOBINOMETER

*Improved Form*



This instrument uses undiluted blood without the use of capillary pipettes, thus eliminating sources of error.

The color scale is of glass, which is much more permanent than liquid standards.

The instrument is made for candle or electrical illumination.

The new features include standardization to sixteen grams per 100 cc equal to normal.

Gram scales as well as percentage scales are furnished with all instruments.

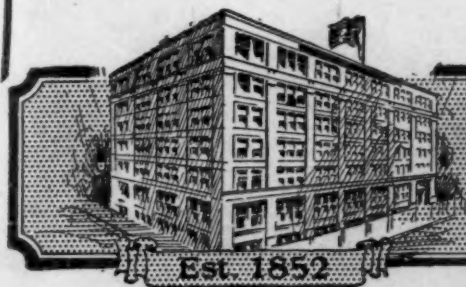
Readings can be reported directly either in grams or in percentage, as may be desired.

All Dare Haemoglobinometers are tested against the Van Slyke oxygen capacity method.

The above improvements are furnished without extra cost.

*Descriptive circular and price list upon application*

(4096)



## E.H. SARGENT & CO.

155-165 East Superior Street · CHICAGO, ILL.  
LABORATORY SUPPLIES

Est. 1852

# SCIENCE

VOL. 75

FRIDAY, JANUARY 1, 1932

No. 1931

<i>American Association for the Advancement of Science:</i>	
<i>The Romance of the Next Decimal Place:</i> PROFESSOR F. K. RICHTMYER .....	1
<i>Research and Industrial Organic Chemistry:</i> PROFESSOR JAMES F. NORRIS .....	5
<i>Scientific Events:</i>	
<i>British Vital Statistics; The Thayer Ornithological Collection; Medalists of the Royal Society; Award of the Chandler Medal to Professor Conant</i> .....	10
<i>Scientific Notes and News</i> .....	13
<i>Discussion:</i>	
<i>Twisting in Lower Forms of Plants:</i> PROFESSOR E. G. HASTINGS. <i>Meteorites in Sedimentary Rocks?:</i> PROFESSOR W. A. TARR. <i>Possible Relation of Age at Sexual Maturity in Birds to Daily Period, Intensity and Wave-length of Light:</i> PROFESSOR T. H. BISSENETTE. <i>"Entamoeba" Phal-lusiae:</i> PROFESSOR MAYNARD METCALF. <i>Naturally Deposited Eggs of the Myxinoidea:</i> PROFESSOR J. LEROY CONEL. <i>Sedimentation and Sedimen-tology:</i> H. WADELL .....	16
<i>Reports:</i>	
<i>Science Booklets from the American Association:</i> JOSEPH L. WHEELER .....	20
<i>Scientific Apparatus and Laboratory Methods:</i>	
<i>Cultural and Inoculation Methods with Tilletia Species:</i> PROFESSOR T. C. VANTERPOOL. <i>A Ther-mophil Nitrite Former:</i> EVA GALBREATH CAMP-BELL. <i>Museum Tags of Chemical Proof Paper:</i> KARL P. SCHMIDT .....	22
<i>Special Articles:</i>	
<i>The Distribution of Extra-Galactic Nebulae:</i> DR. EDWIN P. HUBBLE. <i>The Hemoglobin Content of the Blood of the Hen: A Statistical Study of In-fluences and Relations:</i> DR. H. H. DUKES, DR. L. H. SCHWARTE and PROFESSOR A. E. BRANDT .....	24
<i>Index to Volume 74</i> .....	i
<i>Science News</i> .....	8

SCIENCE: A Weekly Journal devoted to the Advance-ment of Science, edited by J. McKEEN CATTELL and pub-lished every Friday by

## THE SCIENCE PRESS

New York City: Grand Central Terminal  
Lancaster, Pa. Garrison, N. Y.  
Annual Subscription, \$6.00. Single Copies, 15 Cts,

SCIENCE is the official organ of the American Associa-tion for the Advancement of Science. Information regard-ing membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

## THE ROMANCE OF THE NEXT DECIMAL PLACE<sup>1</sup>

By Professor F. K. RICHTMYER

CORNELL UNIVERSITY

In the year 1896 the *Beiblätter zu den Annalen der Physik* devoted 1,032 pages to reviewing the literature of physics. In 1930 the corresponding journal re-quired almost five times that amount of space.

The *Physical Review* for 1896 contained 490 pages of text. Computed on the basis of the same size and form of page, the *Physical Review* for 1930 contains over 5,000 pages—an increase of over tenfold.

At the present rate, graduate schools in America are granting ten times as many doctorates in physics as they did at the beginning of the century.

If we take into account the large amount of re-search in technical, industrial and governmental lab-oratories which is never published, and if we ignore the still larger amount of work in engineering which has grown directly out of physics and is published in engineering journals, we should probably be justified in making the statement, which I believe to be con-servative, that there is now in progress from twenty

to twenty-five times as much research in physics as there was a third of a century ago.

Physics in 1931, however, differs from the physics of, say, 1895 not only in volume of activity, great as that is to-day, but also in basic theories and view-point, as well as in underlying factual content. The physicist of 1895, in his wildest imagination, could not have dreamed of x-rays and radioactivity, each to be discovered within a year; of the quantum theory, to be proposed before the century ended; or of the rôle which the then hypothetical electron was to play not only in altering completely the whole framework of physical theory but in making possible inventions and other developments which were to revolutionize certain important phases of our economic and social life. Indeed we of to-day are so impressed with both the quantity and the fundamental nature of our contribu-tions that we are wont to think, and even sometimes to remark, that the progress which physics has made since 1895 exceeds that of all preceding time.

But if we view our science objectively and in

<sup>1</sup> Address of the retiring vice-president of Section B—Physics, American Association for the Advancement of Science, New Orleans, December 30, 1931.

unbiased historical perspective we must conclude that this extravagant evaluation of the prowess of the twentieth century physicist is hardly justified. The generation of physicists immediately preceding ours likewise took giant strides. When silhouetted against historical background Maxwell's electromagnetic theory and its remarkable experimental confirmation by Hertz loomed up as large to the physicist of 1895 as the de Broglie-Schrödinger wave theory of matter and its experimental confirmation by Davison and Germer does to the physicist of to-day.

Stepping back another 30 years from 1865: With what pride must the older contemporaries of the young Maxwell have viewed such outstanding achievements of their generation as Faraday's discovery of electromagnetism. What could be more fundamental and far-reaching, even outside of physics proper, than the law of conservation of energy firmly established by the experiments of Joule in 1846? Had not one of their number, Foucault, with unsurpassed experimental skill, actually settled for all time the two-century-old conflict between the corpuscular and the wave theory of light by showing that light actually travels slower in water than in air?

And to all these claims of preeminence we can imagine the shades of the next older generation protesting: "Ah, but you forget that Joule was but completing Rumford's work begun in 1798; that the starting point of Faraday's researches was Oersted's discovery of the magnetic effect of an electric current (in 1819); that Young and Fresnel in the first two decades of the nineteenth century really established the wave theory of light, which was merely confirmed by Foucault's experiments."

If we trace this story still farther back we find that, except for the more or less sporadic contributions of the ancient and medieval world, the science of physics arose almost asymptotically out of comparative nothingness only a short time ago, at least as measured on the time scale used by the historian to mark the progress and development of human society. Whether we say that physics began with Galileo, or with Copernicus, or with Roger Bacon is relatively unimportant. Of great importance is that fact that since its beginning physics has increased, with each generation, in geometrical ratio. If there is anything remarkable in our twentieth century physics it is perhaps not so much because of the fundamental nature of the changes since 1900, as because of the number of those changes which have taken place in a single generation—a remark which has probably been made by each of the generations which has preceded us!

Now, what are the factors which have made this accelerated growth possible? Volumes have been written in attempts to answer this question for all

science, as well as for each science in particular. It is generally agreed that it is no accident that the beginnings of modern science were contemporaneous with the discovery of the art of printing; and that the rate of growth of science has followed closely improvements in that art. When permanent records of the works and thoughts of one generation could be quickly and cheaply made, not only for ready exchange among the members of that generation but for passing on to the next, progress became possible.

Further, increased speed in the transmission of intelligence, both by development and improvement in systems of transportation and by such agencies as telegraphy, cable and telephone, have reacted to speed up scientific research. It is said that within forty-eight hours after American newspapers had printed the cable dispatch reporting the discovery of x-rays by Roentgen, at least six x-ray photographs had been made in laboratories on this side of the water. On the contrary, Henry did not learn of Faraday's experiments on electromagnetism until several months after the announcement was made in England.

Then, too, there is the reaction which has come from the application of science in so many aspects of modern life. The present great volume of scientific research is made possible in very large part because society believes such research is useful.

We must not forget, also, that, probably because of this demonstrated usefulness, the work of the scientist is no longer viewed with suspicion and intolerance. He is free, except for here and there a backward community, to hold such theories and to perform such experiments as he pleases. No longer need a Galileo abjure, nor a Roger Bacon spend half of his life in prison because he had made discoveries that proved to him that previous theories were untenable.

This freedom to experiment and to interpret the results of experiment has been a determining factor in the development of the so-called laboratory sciences. Observation merely of the phenomena in the world about us would be quite ineffective in advancing such a science as physics.

Now, broadly speaking, laboratory research in physics falls under two classifications. First, there is the pioneer work of exploration and of rough measurement as a result of which phenomena are discovered and classified. Second, there is the precise measurement and study of these phenomena in an attempt to set up physical relations as exact as the technique at hand may permit. It is this latter type of measurement which has given to physics the name "exact science"—an appellation which those of us who attempt to make so-called "precision" measurements know to be entirely unjustified! Otherwise expressed,

we may say that the purpose of making such careful measurements is, to borrow Rowland's famous phrase, "to investigate the next decimal place."

Now why should one wish to make measurements with ever-increasing precision? Having measured the velocity of light to four significant figures, why should one wish to know what the next "decimal place" is? "Because making such measurements is great fun," the late Professor Michelson is said to have remarked. "Because only by making such measurements can we establish exact physical laws," will be another obvious answer. To these two answers I wish to add a third: "Because the whole history of physics proves that a new discovery is quite likely to be found lurking in the next decimal place." If the making of a new scientific discovery is thrilling to the discoverer, and if a romance is a human event which thrills the participants, then we may justly speak of the "romance of the next decimal place." To devise methods of making measurements with greater precision than has ever been attained before; not only to establish so-called exact laws, but possibly to discover new and unsuspected phenomena furnish both fun and thrills not surpassed by any other quest in scientific research.

A well-known industrial physicist once remarked that no physical measurement was worth making which required a precision in excess of one per cent. Let us examine a few typical cases to see what sort of structural members would be lacking from the framework of modern physics if investigators had been content with one per cent. as a limit of precision.

One of the most conspicuous examples of the importance of precise measurements is to be found very early in the history of physical science. In 1543 Copernicus revived the long-discarded heliocentric theory of the universe, postulating that the planets move round the sun in circular orbits. Possessing a qualitative rather than a quantitative background, the theory made slow headway. Had no further evidence been obtained, there is no *a priori* reason to believe that Copernicus would have been more successful in convincing a skeptical world than was his predecessor Aristarchus eighteen centuries earlier.

But then came Tycho, a man to whom, as to our own Michelson, the making of fine instruments and their utilization in research was "great fun." Further, Tycho's own theory of the universe, quite at variance with that of Copernicus, could be established only by observing the motions of the planets with much higher precision than had yet been attained.

And so Tycho began to investigate the "next decimal place." After twenty-five years of the most painstaking devotion to the design and use of his instruments he had accumulated a series of observations on planetary motion not only by far the best in existence

at the time but still regarded with wonder and admiration when we consider the crudeness of his apparatus as compared with our own. It is said that in the delirium of his death-bed Tycho prayed that his life might not have proven useless. We can well imagine that his prayer arose from a realization that his life work consisted only in a mass of observations and that he had failed to prove his theory of the structure of the universe. What would posterity think of him for having done nothing but observe?

Such questions are still asked to-day. Not only men of the town but not a few of even those of the gown are wont to belittle the endeavors of those whom they call "hair-splitting scientists," who devote their lives merely to devising and to using instruments and methods intended to make four significant figures grow where only three grew before.

How completely was Tycho's prayer answered during the century following his death (1601)! Kepler's use of Tycho's data is too well known to require extensive comment. After years of the most intensive study Kepler finally found that the hypothesis of circular motion as applied to the planet Mars was inconsistent with Tycho's observations, there being at certain points in the orbit of Mars a discrepancy between the predicted and observed position of as much as eight minutes of arc—the angle subtended by the lead of an ordinary lead pencil at some twenty feet!

Accordingly, Kepler rejected the principle of circular motion, a principle assumed by Copernicus and held unquestioned for 2,000 years. After various trials and failures, he was finally led to try an ellipse. By placing the sun at one focus, Tycho's observations were satisfied. Conjecture as to the nature of the planets' paths had given way to proof that the paths of the planets were ellipses. A most important law of planetary motion had thus been discovered. "These 8 minutes (of arc) alone," Kepler later wrote, "have led the way towards the complete reformation of astronomy."

But not only astronomy! One may trace a direct path from Kepler's proof of the elliptical nature of the planetary orbits to Newton's proposal and ultimate proof of the inverse square law of gravitation. Thus Tycho's study of the next decimal place had not only led to the acceptance of the Copernican theory of a heliocentric world, but had influenced most profoundly both physics and philosophy. For, without such careful measurements, the true paths of the planets must ever have been a source of conjecture, confirmation that the law of gravitation extends at least to the boundaries of the solar system would have been wanting, and man would not have been able to envision a universe governed by immutable laws.

The century which followed Newton did not see

much attention paid to the making of precise measurements, at least by physicists. Nor, in turn, were there many significant advances recorded. It may be not without point, however, to make mention of the fact that Newton's failure to investigate the next decimal place, in his study of the relation between index of refraction and dispersion, led him to the erroneous conclusion that these two quantities are proportional and that therefore achromatic optical systems are impossible, an error which persisted for many decades.

It is generally agreed that the first two or three decades of the nineteenth century mark the beginning of a new era in the history of physics, in that during this brief period there were introduced basic concepts as to the nature of light, heat, electricity and magnetism which provide the foundations of so much of modern science. It is by no means a mere coincidence that this period saw also the general recognition of the important part which precise measurements were to play in the development of physical theory. Thus, Young's discovery of the interference of light, although not technically "in the next decimal place," was essentially the result of precise adjustment of apparatus and of careful observation. In this class also falls Faraday's discovery of electromagnetic induction, since his observance and interpretation of the minute deflection of his galvanometer led the way to further study and to the establishment of the laws of electromagnetism. Rumford's qualitative theory of the nature of heat was no more convincing than was Aristotle's theory of the solar system. But when Joule actually proved that 772 foot pounds of mechanical energy are required to raise the temperature of one pound of water one degree Fahrenheit the quantitative relation thus established provided an argument as cogent as were Kepler's elliptical orbits.

Indeed, one outstanding characteristic of nineteenth century physics is the extent to which the making of precise measurements, *merely for the sake of securing data of greater accuracy*, became a recognized part of research in physical laboratories. This point is aptly illustrated by Lord Rayleigh's determinations of the absolute density of gases in the early nineties.

Proust's law demanded that the ratio of the respective densities of oxygen and hydrogen should be 16:1. The measurements of this ratio by Regnault as early as 1845 yielded 15.96:1, a result in agreement with Proust's law almost within experimental error. In 1888 Rayleigh attacked the problem anew, and, after a long investigation described by him as "unusually tedious," found that the ratio was 15.882:1, thus proving untenable the theoretical value of 16:1.

Having thus developed an improved technique for measuring the density of gases with great accuracy,

Rayleigh, for no apparent purpose other than to satisfy his curiosity, decided "before leaving the subject (to ascertain) not merely the relative but also the absolute densities of the more important gases." In the course of this investigation he found that nitrogen, prepared from its chemical compounds and thus presumably pure, had a density of 1.2505 grams per liter, while that prepared by removing oxygen from ordinary air had a density of 1.2572 grams per liter, a difference of about  $\frac{1}{2}$  per cent. which previous and less precise determinations had failed to detect. After eliminating one by one the various possible sources of contamination with known gases, Rayleigh concluded that the difference in density must be due to the presence in the atmosphere of a hitherto unknown gas more dense than nitrogen. This clue led Rayleigh, in collaboration with Ramsay, directly to the discovery of argon. Subsequently the whole series of noble gases was discovered.

Seldom has a discovery been more fruitful. Occupying, as they do, unique positions in the series of the elements, these noble gases may be said to provide the very foundation stones for that elaborate and beautiful edifice which we call "atomic structure." The use of helium, neon and argon for so-called practical purposes is commonplace. Whereas Rayleigh with great difficulty prepared a few cubic centimeters of argon in 1894, to-day that gas is produced in large quantities for commercial purposes. "Bigger and better" dirigibles are made possible through the use of helium. Even the legal profession is reaping a rich harvest from the crop which grows out of Rayleigh's fifth significant figure, for it is said that more than a million dollars has been spent in litigation over the neon-sign patents!

That last decade of the nineteenth century, one of the most fruitful and romantic in the whole history of physics, provides a close parallel to the discoveries of Tycho and Kepler. For, just as the century was closing Planck, analyzing the data of Lummer and Pringsheim on temperature radiation, announced the quantum theory, which was destined to revolutionize the whole trend of physics and, though perhaps to a lesser extent immediately, of philosophy. Just as Tycho's observations agreed with the theory of circular orbits except for certain small differences in parts of the orbit, so the data of Lummer and Pringsheim agreed with Wien's law of temperature radiation, except for certain small discrepancies at long wavelengths. In both cases the theorist, placing confidence in the accuracy of the observations, was led to propose a new and a very fundamental theory.

This principle of the importance of the next decimal place, in leading to new discoveries is, though perhaps unconsciously, given recognition in the fact that

one expressed purpose underlying so much of our modern research in physics is to increase the precision with which physical phenomena may be observed. For 25 years attempts to observe the refraction of x-rays failed. About 1920 Siegbahn and Larsson, pushing measurements of wave-lengths of x-rays to higher and higher precision, found that the wave-length of Cu Ka radiation, as measured in first order reflection from a mica crystal, differed from similar measurements in the eleventh order by about 0.15 per cent. They correctly attributed this difference to refraction of the rays as they entered the crystal, a phenomenon hitherto unobserved. To-day indices of refraction for x-rays (strictly speaking, the difference between the index and unity) are measurable with a precision in excess of 1 per cent. Until a few years ago no one had succeeded in producing an x-ray spectrum by reflection from a ruled grating. Recently, by use of such a grating, Bearden has reported measurements of x-ray wave-lengths with an estimated probable error of 0.01 per cent. As is well known, the slight discrepancy between the values so obtained and those yielded by use of a crystal grating has necessitated a critical reexamination of the whole technique of x-ray spectroscopy, and perhaps requires some fundamental modifications in our concepts of crystal structure.

In 1900 Drude, in his "Theory of Optics," remarked that "this (radiation) pressure is so small

that it can not be detected experimentally." Almost before Drude's book was released from the press, Lebedew in Europe announced the experimental discovery and rough measurement of this phenomenon; and within three years Nichols and Hall in America reported measurements of radiation pressure with an estimated probable error of about one quarter of 1 per cent. The bearing of these measurements on theories of radiation is too well known to need comment.

In a little over a decade, Thomson's apparatus for studying positive rays evolves into Aston's precision mass-spectrograph, in which the relative masses of atoms can be measured with a precision of the order of one part in 10,000. After observing the "fine structure" of spectral lines the spectroscopist goes on to observe "hyperfine structure." A recently reported critical examination of existing data leads to the conclusion that the most probable value of "e," the charge carried by the electron, is  $4.7721 \times 10^{-10}$  as e.s.u. instead of  $4.774 \times 10^{-10}$  as previously used. From each such extension of the precision of measurement there results either a significant modification of theory, or not infrequently a new discovery. So frequently has this happened in the history of physics that to sum up what I have said I am disposed to conclude by paraphrasing a famous saying: "Look after the next decimal place and physical theories will take care of themselves."

## RESEARCH AND INDUSTRIAL ORGANIC CHEMISTRY<sup>1</sup>

By Professor JAMES F. NORRIS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

I EXAMINED a short time ago the advertisements in a copy of *Industrial and Engineering Chemistry* to see to what extent the pages reflected the recent development in this country of industrial organic chemistry. I found 42 organic compounds advertised which are available for large scale use. Many of these are new substances; the rest have been used but are produced now at lower prices and in a purer condition than in the past as the result of the application of new synthetic methods. In the list were several compounds of importance on account of their use as intermediates in the preparation of a great variety of technical products. A study of the methods by which these results have been reached shows clearly that chemical research of a high order is the foundation upon which the achievements rest. A broader

survey of the present condition of the organic chemical industry leads to the same conclusion.

The division of engineering and industrial research of the National Research Council has as one of its important activities the study of the relation between research and industry and has demonstrated in its publications the controlling significance of this relation.

The chemical industry of the United States has grown rapidly since the world war. It stands high in the list of industries arranged according to the number of men employed, returns and capital invested; it is thus an important factor in the economics and well-being of the country. I shall limit myself in this address, however, to organic chemistry, the field in which my knowledge and chief interest lie.

The supply of many important chemical compounds used in a variety of industries was suddenly cut off when the country entered the recent war. It was

<sup>1</sup> Address of the retiring vice-president and chairman of Section C—Chemistry—American Association for the Advancement of Science, New Orleans, December, 1931.

necessary to manufacture without any background of experience a great variety of substances, such as dyes, pharmaceuticals, etc. The methods used in the preparation of these substances were in many cases protected by patents owned by foreign corporations. Under the circumstances the United States Government took over such patents and provided a way to make possible the manufacture of these essential materials. In order to put the patented processes into operation it was found necessary to carry out a large amount of research based on the scanty and more or less indefinite disclosures in the patents. This procedure was costly but yielded the desired results. Most important of all was the conclusion that research is a factor of prime importance in industry. The learning of this lesson by the executives of corporations who dictated policies and expenditures proceeded slowly at first, but after the results became more and more evident the conservatives were finally convinced.

I had an excellent opportunity in 1924-1925, as chairman of the division of chemistry and chemical technology of the National Research Council, to study the relation between research and the organic chemical industries. The investigation brought out the fact that certain great industries were not utilizing chemical research adequately. An attempt was made by the division to bring about cooperative research in certain industries. The response by executives was not, at first, encouraging. The president of a large petroleum company told me it was not the business of the chemist to meddle in the affairs of the industry. His company had millions of dollars invested in plants. It was satisfied with the results. He did not want anybody to do anything to make these plants obsolete.

A high executive in another industry told me he did not believe it good business to spend money on research to develop new products or methods. He had found it better to let some one else bear the expense of such work, most of which proved of no value. If anything worth while came out of it he could afford to buy it. What a change has come about in seven years. The two industries to which I have just referred are now spending millions of dollars in research.

The financial depression has had little influence on the research activities in chemical industries. Statistics gathered by the American Chemical Society show that few trained research men have lost their positions. One of the progressive organizations had more men on this type of work this summer than ever in the past.

A careful study of the factors involved in the relationship between research and industry is leading to a fuller appreciation of the value of results that follow

the use of research as an industrial tool. At this time I shall refer to but two of these factors. The first and most important is the attitude of the executives. I have already said that this is improving, but much remains to be done. It was not long ago that the consolidation of several chemical industries into a large corporation promptly resulted in the abandonment of research and the discharge of the men who were advancing the industries involved. It was also not long ago that a chemist from Switzerland, who was well informed as to the condition of industry in his own country and in Germany, pointed out the handicap under which certain American industries function as the result of being under the control of men ignorant of chemistry. These conditions also are changing. I once expressed to a friend, who had been successful in the direction of the research of a corporation, my regret from the standpoint of science that he had been transferred to an executive position. He showed me that my attitude was wrong. In the new position he could influence the directors of the corporation to adopt a more liberal and better understanding policy in regard to research.

Some of the most brilliant industrial developments in organic chemistry have been the result of research that required from five to ten years to reach the goal. Methanol and gasoline synthesized from coal have been the reward of long-continued endeavor. It required the foresight of one who knows what research can do to enter upon such a long chase. As each success is achieved the way for future development becomes easier.

The winning of the confidence of executives in the money value of research is proceeding rapidly. It is reassuring that a large number of chemical industries has contributed annually to the American Chemical Society a substantial sum to help in the publication of *Chemical Abstracts*. Appreciation of the work done in preparing men for research in chemistry is shown by the fact that over thirty students are financed by chemical industries at Johns Hopkins University. One large corporation maintains fellowships in chemistry at about twenty educational institutions. The men receiving the aid are not restricted in regard to the subject of their researches. There is a large number of fellowships of a different type established in colleges and universities. In these the research problems are closely allied to the industries which support them. The object in these cases appears to be more the results hoped for than the training of research workers.

The increased use of research in chemical industry has resulted in the rapid growth of centralized research organizations. Under certain conditions it has been found better to use the broad background of experience of these organizations and the services

of their skilful research men rather than to place the problem in a laboratory closely associated with plant operation.

The division of engineering and industrial research has done good work in helping to bring to the attention of executives of corporations the work of industrial research laboratories. The division organized and conducted two tours of inspection for executives through the laboratories of a large number of industries. It is planned to extend this service to the research organizations of Europe.

The second most important factor in the development of industry by research is, in my opinion, the personnel of the laboratories. This factor is of particular interest to those who have the responsibility of assisting in the education of research chemists. Much study of the problem involved in training minds is being carried out outside the schools of pedagogy. The American Council of Education has been endeavoring to formulate what qualities and qualifications professional scientists should possess. One of its studies has been devoted to organic research chemists. A teacher interested in helping to build an individual as near the ideal as possible sees that he can help in ways apart from the use of the old-fashioned formulas of his profession.

In recent years the methods and personnel of the industrial research laboratories have changed rapidly. The empirical approach to the solution of a problem has largely disappeared and has been replaced by coordinated investigation carried out with the use of the scientific methods and with a knowledge of the latest findings and instruments of fundamental science. The industrial laboratories keep informed as to the new knowledge resulting from research in the universities. Requests are received from such laboratories for reprints of papers which apparently are only of theoretical interest.

The change in the industrial laboratories has come about as the result of a change in personnel. I was consulted several years ago in regard to the appointment of a director of a proposed research laboratory for a chemical industry, which was conducted largely by rule-of-thumb methods. The directors insisted on the appointment of a well-informed organic chemist, preferably a university professor, who had no experience in the industry which he was expected to develop. In this case there was good judgment in the point of view.

Opportunities are rapidly decreasing for the advancement in his profession of the chemist whose scholastic experience is limited to a four years' course leading to the degree of bachelor of science. To get ahead he must put chemistry behind him and become a manager or executive. The men to-day who are developing the industry are some of the best of those

who have learned the methods of research in winning the doctor's degree. It may be profitable to digress at this point to consider some of the effects of this change. For those of us who are training these men it is necessary to know what experience has shown to be the best type of preparation for this work.

The scientific background of the organic chemist of thirty years ago was largely limited to a knowledge of the properties and chemical behavior of the substances with which he had to deal. He used the physico-chemical concept of molecular weight and the laws relating to the effect of solutes on the freezing and boiling points of solutions. He was prepared to undertake the study of the structure and the synthesis of organic molecules—the major problems of the time.

The advances made in physics and physical chemistry have furnished the organic chemist with new fundamental concepts, methods and tools, which have been applied with astounding success; and other possible aids of this sort are now waiting to be used in the study and control of organic molecules. The application of thermodynamics, thermochemistry, the laws of vapor pressure, rates of reaction and their temperature coefficients, the concepts of free energy, chemical equilibrium and ionization, catalysis, x-rays, and different types of energy with varying intensity factors—these and other important facts and generalizations have broadened the methods of research in organic chemistry, and have been applied in the solution of industrial problems.

For the research chemist who enters the industrial field a knowledge is important of the principles of chemical engineering which follow from the application of those laws of physics and physical chemistry which have to do with the physical relationships between molecules.

Those who direct the education of students of organic chemistry should see to it that the preparation for future work includes training in the principles of physical chemistry and their use. It was not so long ago that one of the leading universities of the country had no requirement in physical chemistry for men awarded the doctorate in organic chemistry. Happily, conditions are improving.

The growth of the use of research in the industries based on chemistry is indicated by the rapid increase in the number of men awarded the degree of doctor of philosophy in American universities. A compilation made by the National Research Council shows that much the larger number of these degrees is in the field of chemistry. Many of the young men awarded this degree have entered industrial research laboratories, where they are happily at work on problems of great interest, are supplied with every facility

and are in a congenial scientific atmosphere. Their value is clear from the compensation they receive.

The business world, apart from the industries themselves, is learning the importance of research. Some of the more progressive and larger banks seek information and advice before investments in or loans to certain corporations are made. The banker wants to know what percentage of profits is expended in research, something of the personnel and aim of the laboratory, the extent to which there is diversification in the products manufactured and the future possibilities of new ventures. Great financial loss has resulted from investments made without the judgment of well-informed experts.

There is time to make a brief survey of a few of the achievements of industrial organic research in this country, as examples of the application of the more recently applied methods of investigation. The substances considered can be conveniently grouped according to the causes which led to their investigation.

A constant aim of the manufacturer is to reduce cost. The cost of a material which is necessary in the production of a new and useful product determines whether or not the product is made and used. There are now a number of substances possessing properties that would lead to their extensive use if the cost of the intermediates required in their manufacture could be reduced a few cents per pound. Potentially large industries are waiting such reduction.

The production of certain aliphatic acids has been studied from this point of view. The price of acetic acid, which is so extensively used, is yielding to the effects of research. The search for new methods of preparation, rather than the improvement of the old, has yielded a process from calcium carbide made from coal and another based on the catalytic oxidation of alcohol by air. It is stated that with the use of alcohol the cost of the acid can be reduced to a surprisingly low figure. A search is now being made for cheap propionic acid. Success will depend on the use of a very cheap material for the source of the carbon atoms.

Several amyl alcohols prepared from the pentanes in petroleum are now available. The investigation necessary for the successful industrial use of the reactions involved required much time and skilful effort.

The modern method of preparing alcohol free from water for industrial use is a striking example of the application of the principles underlying the vapor pressure of two and three component systems.

The industrial preparation of esters, as illustrated in the case of ethyl acetate, brings out clearly how physico-chemical principles and chemical engineering solved in a very neat way a problem of organic chemistry.

A new process has recently been announced for the preparation of higher aliphatic acids and alcohols from fats as the result of reduction by hydrogen under pressure. The results in all the cases cited were produced by modern research methods. It would lead too far to amplify this statement. A consideration of the development of our knowledge as the result of the study of the chemical behavior of molecules under high pressures and at high temperatures would be of value only if furnished by a specialist in this field.

Two important aromatic intermediates, phenol and aniline, are now produced from chlorobenzene by new processes, which in the light of the older organic chemistry seemed well-nigh impossible. But the application of the newer knowledge and methods yielded a solution of the problem.

The use of waste materials and by-products to prepare valuable substances has always been a fascinating field of endeavor to the chemist. It is only recently that outstanding results have been obtained. The wastes from oats, cottonseed and corn-stalks are now converted into chemical compounds of value.

The gases produced in the cracking of petroleum in the preparation of gasoline, until recently, were of value only as a source of heat. Years have been spent in the study of the conversion of the unsaturated hydrocarbons contained in these gases into alcohols. An application of a knowledge of the influence of the structure of hydrocarbons on the rates at which they react with sulphuric acid of varying concentrations, converted an empirical and unsatisfactory process into one that yielded purer products and compounds not obtainable by the older method. Tertiary butyl alcohol was changed from an expensive research chemical to one that can be sold in car-load lots at a low price.

A third driving force behind industrial organic research is the desire to prepare substances that possess the particular physical properties required for a specific use. The change from paint to lacquers in the automobile industry brought forward the problem of solvents which led to much research in their use and their preparation.

Artificial silk and plastics have kept chemists at work for years. It is probable that new developments will soon appear. The thorough study of certain types of condensation reactions and the relation between physical properties and the length of the carbon chain in products formed by condensation have led to the production of compounds which may become important factors in the textile industry.

Synthetic rubber has lost most of its industrial significance, but fundamental research carried out by industry on the process of polymerization has led to the preparation of a product that will probably re-

place rubber in certain of its uses. The new material possesses properties that are superior to those of rubber from the standpoint of these uses.

The extensive development of ethylene glycol and its derivatives has added a number of compounds to the products that have found, or are waiting to find, industrial uses. The recent great expansion of the use of cellophane, after the substance had been known so long, must give hope to those who have spent much time in the development of substances that have not yet found their place.

I have but mentioned a very few of the substances that are worthy of note in a review of the part played by research in the organic chemical industry. These were chosen as examples to show to what extent research of the highest type was used. The chemist familiar with the steps by which the results were achieved is impressed by the methods by which they have been reached.

When one has reviewed the past and has endeavored to relate the causes with the results obtained, it is a pleasant mental diversion to look into the future and try to sketch the flow of events. Zest is added to this play of the imagination if an attempt is made to find new causes and new conditions that would probably lead to accelerated progress.

It is easy to see important future developments resulting from the application of known knowledge in the study of industrial problems. These developments are assured. But much lies ahead awaiting the accumulation of yet undiscovered facts and principles to be applied. As I have already indicated, industrial research chemists are using effectively the results of "pure" research, but advance is impeded by a lack of more detailed knowledge of the molecules themselves with which they are busy. Past studies have been devoted largely to the investigation of the interaction between molecules; and from the results obtained conclusions have been drawn as to the arrangement of the atoms in the molecule. The theory of structure has led to great triumphs in synthesis, but the graphic formulas we use tell us nothing of the molecules except a probable arrangement of their constituent atoms. A wide background of facts not indicated in a formula must be used in interpreting the significance of the structural relationships represented.

We know but little of how the atoms in a molecule are held together and how different atoms in relatively different positions affect the so-called bonds between the atoms, which we represent as straight lines or by two dots. I recall a statement made by Professor Remsen when he was lecturing to his students on double salts. He wrote the formula of such a salt, in the way used then, with a period between

the two simple salts from which it was prepared. He pointed to the period and said, "Gentlemen, that period has been a full stop to thought." For years the lines written between atoms in a structural formula satisfied organic chemists. Lately two dots have replaced the line in an attempt to make use of the concept of electrons. I fear to some the change is satisfactory and the history of the line will be repeated.

Organic chemists should learn a lesson from the physicists. One can not use too strong or flamboyant words in expressing an appreciation of the results of ten years' intensive study of atoms. What has been accomplished has opened new roads that lead to the very heart of the atom. A similar fruitful field lies before the organic chemist in his molecules. The problem may be harder or it may be easier in some of its aspects, but it is certain that it warrants study and that the results will be repaying.

How is this new knowledge to be gained by which organic chemistry will be changed slowly from a science largely empirical to one based on principles? Is the way followed to-day the best? To what extent can the industries themselves help? In the applications of electricity, practice is working at the borderland between the known and the unknown, and the industry in its laboratories is pushing the boundary farther ahead. Have we a right to hope that those who control the policies of the research laboratories of the organic chemical industries will make possible a search for the fundamental principles underlying these industries? There has been a start in this direction, but the strong pressure toward the immediately practical application is hard to resist.

The kind of study that I have in mind is costly, and the results come slowly. How best can it be accomplished? Organization based on cooperative effort appears to be one solution of the problem. We have seen, since the war, cooperation between government and industry in Great Britain. Extensive laboratories supported by public funds and by contributions from the more important industries have yielded results which are the common property of those who have cooperated. The canners in the United States support a laboratory that has been a great success.

The method has many evident advantages and has demonstrated the value of cooperation. As far as I am informed the laboratories have been busy, almost exclusively, with practical problems. It would be a long step ahead if industry would undertake in the same spirit more fundamental investigation.

Let me present one illustration of what might be done. In 1929 over 300,000,000 barrels of crude petroleum were converted, in the United States, into

commercial products by processes that involved chemical changes in the constituents of the crude oils, which differed widely in composition. The methods used in the "cracking" processes employed are based on empirical knowledge. Very little is known as to the behavior of the many individual substances, largely of unknown composition, in the complex mixtures used. If the several organizations in the industry would contribute in a cooperative spirit to the support of a laboratory to study fundamentally the molecules of hydrocarbons, the results in time would, without doubt, be of the greatest value. As little as one cent for each ten barrels cracked would yield at least \$300,000 annually for such work. It is my opinion that the organization and the research program for such a laboratory could be worked out in a way to ensure successful operation. No attention should be paid to immediate applications of the results of the work, and publication of these results should be unrestricted. The utilization of the findings of the laboratory in developing processes should be undertaken by the cooperating contributors to the enterprise. A part of the available funds could be used in supporting those researches in university laboratories that had to do with aspects of the fundamental problems of the industry.

I have outlined earlier in this address the broaden-

ing of the view in regard to research of the men who control the finances of great corporations. The next advance will come when these executives learn to appreciate the dependence of applied science on "pure" science to such a degree that they will see the value of devoting a fraction of earnings—even an almost infinitesimally small fraction—to the support of the "goose that lays the golden egg."

I shall never forget a prophecy made by Elihu Thomson in an address on the electron before the American Academy of Arts and Sciences. He told the little that was known at the time of this constituent of atoms. Foreseeing the possibilities lying in this sub-atomic entity he boldly prophesied that within a few years electrical engineering would be transformed into electron engineering. The prophecy has come true and the lesson to be drawn from it is evident.

The study of the present status of industrial organic chemistry leads to the conclusion that the development of the industry is based on research in which the results of "pure" science has been applied with great success. A stage has been reached which emphasizes the need of a more fundamental knowledge of the chemical units—the molecules—which are used in building up the valuable substances produced by the industry.

## SCIENTIFIC EVENTS

### BRITISH VITAL STATISTICS

THE registrar-general's "Statistical Review of England and Wales for 1930," according to a summary in *The British Medical Journal*, contains statistics of population, births, marriages and divorces, registers of electors and vital statistics of the British Dominions. A table is given showing the populations of England and Wales, Scotland and Ireland as enumerated at each census from 1821 to 1921, and so estimated for each year 1891 to 1930 inclusive. The number of marriages solemnized in England and Wales during the year 1930 was 315,109, against 313,316 in the previous year. The rate in both years was 15.8 persons married per 1,000 persons living. This rate is the highest recorded since 1921, notwithstanding the present economic depression. Of the total marriages 31 per cent. were solemnized during the third quarter, or more than double the number during the March quarter. This preference for the third quarter has been constant since the beginning of the present century, prior to which the fourth quarter had been the favorite quarter for marriage. It is interesting to observe that 22 males and 699 females married at 16 years of age, the lowest legal

age at which marriages may be solemnized, and that while the 22 males married females up to 23 years of age, the 699 females married males of varying ages between 16 and 49 years of age; in only five cases were the bride and bridegroom of the same age. The number of decrees nisi made absolute in respect of dissolution or annulment of marriage was 3,563, an increase of 167 over the figure for the preceding year. The births registered during the year totalled 648,811, an increase of 5,138, though the rate of 16.3 per 1,000 of the population remained the same. This increase in the number of births is probably in consequence of the high marriage rates recorded during the last two years. The proportion of the sexes in the births registered during the year was 1,044 males to 1,000 females, thus continuing the approximate proportion of recent years. There was at the end of the year 1930 a total of 157,948,940 names in the registrar-general's index available to the general public for searches in the registers of births, marriages and deaths. The statistics relating to parliamentary electors give the figures for the 1930 register for England and Wales as 12,101,108 males and 13,629,399 females, making a total of 25,730,507

electors, with increases of 234,314 and 400,400 in the respective sexes over the preceding year.

### THE THAYER ORNITHOLOGICAL COLLECTION

WHAT is perhaps the finest private collection of North American birds, nests and eggs has been given to the Museum of Comparative Zoology at Harvard by the owner and collector, John Eliot Thayer, of the class of 1885. The collection, numbering about 30,000 skins and many thousand sets of nests and eggs, includes almost all the rarest North American birds and their eggs.

Mr. Thayer has sent out many carefully planned expeditions in an effort to secure rare specimens. His parties have visited Alaska, northeastern Siberia, the Queen Charlotte Islands, Lower California and northern Mexico. In Alaska one of his parties discovered the nesting place and secured the only surf bird's eggs known to be in any collection.

The bird skins in this collection are said to be beautifully prepared by the most expert taxidermists. One of the examples of this work is an adult male Labrador duck, a species extinct for sixty to seventy-five years. The Thayer specimen, formerly in the collection of Lord Derby, of England, is probably the best preserved bird of the species.

The Thayer collection recalls the fact that the United States once had parrots living within its borders; four specimens of the excessively rare western race of the Carolina parakeet, a species of parrot, from Oklahoma, will be added to the exhibit of extinct birds already on display at the Museum of Comparative Zoology. There is in Mr. Thayer's collection a series of examples of the extinct Eskimo curlew, or "dough bird," and specimens of the passenger pigeon, the bird which once darkened the western plains, extinct now for thirty years.

The bird skins include many collected by Mr. Thayer's expeditions in the peninsula of lower California. The university collections will also be enriched by a group which fills the gaps in the Harvard series from the Queen Charlotte Islands. There is a series of the Imperial woodpecker from the highlands of northern Mexico, and examples of the now rare ivory-billed woodpecker, together with a section of the cypress log in which is the nesting cavity with the set of eggs found there.

The collection of eggs includes ten eggs of the great auk, extinct since 1845. Harvard has now eleven auk eggs, or about one sixth of those known. There are several California condor eggs, almost the only examples of such eggs found in their natural surroundings. Several eggs of that condor have been secured from birds at the Washington Zoological

Park, but few in the wild surroundings of the rocky coast where the bird nests. The first two sets of the eggs of the spoonbilled sandpiper ever found are in Mr. Thayer's collection. A set of "knot's" eggs taken by Admiral Peary on his last trip to the Arctic is included.

### MEDALISTS OF THE ROYAL SOCIETY<sup>1</sup>

#### COPLEY MEDAL, AWARDED TO SIR ARTHUR SCHUSTER

SIR ARTHUR SCHUSTER was the first to show the important information to be got by measuring quantitatively the magnetic deflection of cathode rays. He showed how, by combining this measurement with the potential difference which generates the rays, it was theoretically possible to determine without ambiguity the velocity, and the ratio of charge to mass, of the particles constituting the corpuscular stream. We owe to him other almost equally fundamental contributions to the study of electric discharge in gases. Thus he showed that the passage of a luminous discharge put the gas temporarily into a conducting state, due to the presence of charged ions: these ions were able to diffuse into a space screened from the discharge by a wire gauze partition, and they could then be put into evidence by showing the conductivity of the gas under electromotive forces of a fraction of a volt. Sir Arthur was the first to show by experiment that in Crooke's radiometer the reaction was not on the sun but on the glass case of the instrument, thereby connecting the action with the residual gas. He has also made many important contributions to terrestrial magnetism. In spectroscopy he formulated independently the Rydberg-Schuster law. He invented the periodogram method of looking for periodicities in statistical material, a method which has been widely adopted by workers in many branches of inquiry, extending even into economics.

#### ROYAL MEDAL, AWARDED TO SIR RICHARD GLAZEBROOK

For fifty years Sir Richard Glazebrook has been closely identified with research on physical standards, and particularly electrical standards. For many years he conducted researches associated with the absolute measurement of resistance, current and inductance, and the results of this work are reflected in the present remarkable accuracy of electrical measurements. The name of Sir Richard Glazebrook is also world-known on account of his directorship of the National Physical Laboratory; it is largely due to his influence on the researches at that institution that

<sup>1</sup> Extracts, as printed in *Nature*, from the remarks made by Sir F. Gowland Hopkins, president of the Royal Society, in bestowing the medals of the society at the anniversary meeting on November 30.

aeronautical science has made such vast progress. Physical science is also indebted to him for that great work, the "Dictionary of Physics," and in international science he has played a conspicuous part.

#### ROYAL MEDAL, AWARDED TO PROFESSOR W. H. LANG

Professor Lang's work on the fossils of the Old Red Sandstone is of high scientific importance. It has led to the discovery and description of a new and unexpected group of plants in which root, stem and leaf are not differentiated. For the first time it thus becomes possible to trace in a circumscribed group the probable origin of these structures from a source in which they did not exist as distinct members. The work was begun in collaboration with the late Dr. Kidston and continued by Professor Lang after the death of his colleague in 1924. Professor Lang's previous intensive studies on the morphology of the liverworts and ferns had eminently fitted him to provide a morphological point of view which has given most important results.

#### DAVY MEDAL, AWARDED TO PROFESSOR A. LAPWORTH

Professor Lapworth's work has been largely concerned with the application of physical methods to the investigation of the reactions of organic chemistry. His study of the bromination of acetone yielded results of primary importance in relation to the reactivity of carbonyl compounds and has formed the basis of many subsequent investigations. His researches on the addition of hydrocyanic acid to organic compounds, besides leading to results of theoretical and synthetical importance, made clear the mechanism of the formation of cyanhydrins. His investigations of the effect of small quantities of water in diminishing the activity of acids in alcoholic solution indicated the existence of the oxonium ion and added considerably to our knowledge of catalysis by acids. Among his more notable synthetical achievements are the synthesis of zingerone, derived from the pungent principle of ginger, and of homocamphor. His work on the mutual influence of groups in the same molecule, his recognition of induced alternate polarity and his classification of reagents as anionoid or kationoid have played an important part in the development of the present state of knowledge of the reactivity of organic compounds.

#### SYLVESTER MEDAL, AWARDED TO PROFESSOR E. T. WHITTAKER

Professor E. T. Whittaker is one of the best known of British mathematicians, his work showing extraordinary versatility. He has written five books, on entirely different subjects, and numerous papers which touch on almost every branch of mathematics. All

his books show, besides their more technical qualities, powers of arrangement and exposition of a most unusual order; and the "Modern Analysis" and "Analytical Dynamics" have had a considerable influence on mathematical thought. Professor Whittaker has made important additions to the theory of the solution of differential equations, ordinary and partial, by definite integrals; to the theory of Lamé and Mathieu functions, the functions of the elliptic and parabolic cylinders and the integral equations associated with them; to the theory of interpolation; and to the theory of the solution of dynamical problems by trigonometrical series. He has also in recent years made a number of interesting contributions to the pure mathematics of relativity, electromagnetism and quantum theory.

#### HUGHES MEDAL, AWARDED TO PROFESSOR W. L. BRAGG

Professor Bragg's recognition of the fact that the Laue diffraction spectra could be considered as produced by reflection from the planes of the crystal lattice, besides being a great simplification of a difficult geometrical problem, was the starting point of two important and fruitful lines of physical investigation, namely, the measurement of x-ray wave-lengths and the elucidation of crystal structure. Work on the first of these led to Moseley's discoveries and their subsequent developments. Bragg's concentration on the second has resulted in a wonderful extension of our knowledge of the structure of crystals, both simple and complex, and of inter-atomic distances and linkages. His work may truly be said to have laid the foundations of a chemistry of the solid state.

#### AWARD OF THE CHANDLER MEDAL TO PROFESSOR CONANT

THE Chandler Medal for achievement in chemical science has been awarded for 1931 to Professor James Bryant Conant, chairman of the division of chemistry in Harvard University, according to an announcement recently made by Professor Ralph H. McKee, at Columbia University, chairman of the Committee on the Chandler Lectureship.

Professor Conant will receive the medal at a national gathering of scientific men in Havemeyer Hall, Columbia University, at 8:15 p. m., on February 5. He will deliver the annual Chandler lecture.

The medal, an outstanding distinction in chemistry, was instituted in 1910 by friends of the late Professor Charles Frederick Chandler, pioneer in industrial chemistry, and a founder of the American Chemical Society. The award was established with a gift which constitutes the Chandler Foundation.

Previous medalists include Dr. Irving Langmuir, Leo H. Baekeland, W. A. Hillebrand, W. R. Whitney, F. Gowland Hopkins, Edgar F. Smith, Robert E. Swain, E. C. Kendall, S. W. Parr, Moses Gomberg and J. Arthur Wilson.

The announcement describes Professor Conant as "one of the most brilliant of the younger organic chemists which this country has produced." He was born in Dorchester, Massachusetts, in 1893. From Harvard he received the A.B. in 1913 and the Ph.D. in 1916.

Upon his graduation he became an instructor in chemistry at Harvard University, and in the following year entered the army as a lieutenant in the Sanitary Corps, later becoming a major in the Research Division in the Chemical Warfare Service.

At the close of the war Professor Conant returned

to Harvard as an assistant professor of chemistry. He became an associate professor in 1925, and a full professor in 1927. Meanwhile he had acted as a visiting lecturer at the University of California Summer School.

Professor Conant is a former chairman of the Organic Division of the American Chemical Society. He is the author of "Organic Chemistry," and joint author of "Practical Chemistry." He has written a series of papers on subjects relating to physical organic chemistry, in which field he has been extensively engaged.

His research has included work in reduction and oxidation, hemoglobin, free radicals and a quantitative study of organic reactions. He is a member of the American Academy of Arts and Sciences and of the National Academy of Sciences.

## SCIENTIFIC NOTES AND NEWS

THE American Association for the Advancement of Science, with some thirty-five affiliated and associated scientific societies, has been meeting this week in New Orleans. This is the second New Orleans meeting, the first having been held there twenty-five years ago. Full information concerning the meeting was given in the preliminary announcement printed in the issue of SCIENCE for November 27, and supplementary statements have been given in other issues. A report of the meeting edited by the permanent secretary will appear in the issue of SCIENCE for February 5.

DR. WILLIAM KING GREGORY, of the American Museum of Natural History, was elected president of the New York Academy of Sciences for 1932 at the annual meeting held in New York City on December 21. The address of the retiring president, Dr. Clark Wissler, was delivered after the annual dinner. Dr. Wissler's subject was "The Primitive Background of Civilization."

MR. H. P. CHARLESWORTH, vice-president of the Bell Telephone Laboratories, New York, has been officially nominated for the presidency of the American Institute of Electrical Engineers.

It is announced that Dr. Harvey Cushing, surgeon-in-chief of the Peter Bent Brigham Hospital and Moseley professor of surgery at the Harvard Medical School, will retire on September 1. He will reach the age of retirement of sixty-three years on April 8.

THE governors of the University of Toronto have accepted with regret the resignation of Professor J. C. McLennan, dean of the school of graduate studies, professor of physics and director of the physical laboratory. Professor McLennan has been granted leave of absence from the end of January and he and Mrs.

McLennan will leave at that time to live in England. His resignation takes effect at the end of June, 1932.

PROFESSOR E. FREUNDLICH, director of the Astrophysical Observatory at Potsdam, delivered on December 2 a lecture on the results of the Potsdam Solar Eclipse Expedition to Sumatra in May, 1929, to determine the deflection of light in the sun's gravitational field and to examine its variation with distance from the sun.

DR. EDWARD TYSON REICHERT, professor of physiology at the University of Pennsylvania from 1886 until his retirement in 1920, died in Florida on December 25, aged seventy-six years.

DR. DANIEL DRAPER, who until his retirement in 1911 had been official meteorologist in New York City for forty-two years, died on December 21 at the age of ninety-one years.

THE Cullum Geographical Medal of the American Geographical Society for 1931 has been awarded to Professor Mark Jefferson, of the Michigan State Normal College. The presentation will be made at the twenty-eighth annual meeting of the Association of American Geographers.

SIR CHARLES SHERRINGTON has been awarded the first Hughlings Jackson Medal of the Royal Society of Medicine and will give the first triennial lecture before the neurological section of the society. The medal and lecture have been established with a fund of £1,110 subscribed in memory of Hughlings Jackson, the distinguished British neurologist.

THE Royal Meteorological Society has awarded the Symons Gold Medal to Professor V. F. K. Bjerknes, of the Physical Institute of the University of Oslo.

The medal will be presented at the annual meeting on January 20.

DR. CARROLL W. DODGE, of Harvard University, has been appointed to a professorship in the Henry Shaw School of Botany of Washington University, St. Louis.

DR. JOHN E. BUCHER, formerly head of the department of chemistry at Brown University, consulting chemist of New York City, has become a member of the staff of Antioch College Research Institute, at Yellow Springs, Ohio.

DR. C. B. WILLIAMS, lecturer in agricultural and forest entomology at the University of Edinburgh, has been appointed head of the department of entomology at Rothamsted Experimental Station.

DR. H. C. DARBY has been appointed lecturer in geography at the University of Cambridge.

THE title of emeritus professor has been conferred by the University of Birmingham upon Frederick William Burstall, from 1896 to 1931 professor of mechanical engineering, and on Arthur Robert Ling, from 1920 to 1931 Adrian Brown professor of brewing and head of the department of malting and brewing and the biochemistry of fermentation.

DR. KITASHIMA, formerly vice-director of the Kitasato Institute, Tokyo, has been unanimously elected director to succeed the late Baron D. Kitasato, founder and director of the institute. Dr. S. Hata has been elected vice-director.

THE sum of \$2,500 which the Rosenwald Fund has placed at the disposal of the American National Committee of the International Union for the Scientific Investigation of Population Problems has been applied to two fellowships. A fellowship of \$1,800 for one year has been awarded to Dr. E. E. Lewis, of Howard University, who is carrying on an investigation on "The Economic Aspects of the Shifts in Negro Population," and one of \$800 for one year to Miss Betty Freeman, of the Johns Hopkins University, who is investigating "The Relation between Fertility in Women and Longevity." A grant of \$500 has also been made to Miss Mary Dublin out of the general fund of the committee, to meet expenses in the conduct of her investigation at the London School of Economics into "The Influence of the Declining Birth Rate on the Mortality from Puerperal Causes."

It was announced at the anniversary meeting of the Royal Society, as reported in *Nature*, that this year the following grants have been made: From the Messel Fund: £800 a year for five years to Dr. Honor B. Fell, of the Strangeways Research Laboratory, for the support of her valuable work on tissue culture; also £150 for the current year, and, after the termination of his 1851 Exhibition Scholarship, £600 a

year for two years, to Dr. M. L. Oliphant, of the Cavendish Laboratory. From the Caird Fund: £2,200 to Professor O. W. Richardson for the purchase of optical apparatus of high resolving power. From the Donation Fund: £400 to Dr. L. S. B. Leakey towards the cost of his West African Archeological Expedition. From the Darwin Fund: £500 a year for four years to Mr. C. S. Elton for research on wild vole populations, together with an additional grant of £250 for capital outlay and field equipment. Dr. S. Adler's researches on kala-azar continue to receive support from the Anonymous Bequest Fund.

A CORRESPONDENT writes: "Professor P. Langevin, of the Collège de France, Paris, who has been in China for some time on an International Educational Mission on behalf of the League of Nations, has accepted the joint invitation of the National Academy of Peiping, the National University and the National Tsing-Hwa University, China, to give a series of colloquium lectures to the physicists and advanced students in physics there. The lectures are expected to continue for one month. The subject chosen by Professor Langevin is: "Les nouvelles dynamiques de relativité et des quanta et leur applications à quelques problèmes de la théorie du magnétisme." It is hoped that the presence of Professor Langevin and his lectures will serve as a stimulus to the building up of an atmosphere and a nucleus for research in physical science in that region—an atmosphere that has been gradually taking shape. In Peiping there are six universities with physics as a department, besides one institution purely for research on that subject. Steps are also under way towards the formation of a physical society with aims and organization along the line of those existing in other countries."

SENATOR HAWES of Missouri and Senator Walcott of Connecticut have introduced a bill which would coordinate the various federal agencies dealing with the conservation of wild life, both plant and animal, including forests, fish and game.

THE British Museum has acquired for its department of manuscripts nine volumes of nineteenth and twentieth-century autographed letters, presented by Dr. C. Davies Sherborn. Almost half the letters are from eminent scientific men, though art and literature, music and drama, and politics and the professions fill five volumes. The names include those of Huxley, Darwin, Geikie, Lyell and Livingstone.

THE Department of Medicine of the New York Post-Graduate Medical School and Hospital of Columbia University announces the opening of a clinic devoted to the study of the capillaries in a variety of diseased conditions. Representatives of the following specialties will study the capillary changes in

the diseases in which they are interested: Diseases of metabolism; diseases of the cardio-respiratory system; diseases of the endocrine glands; migraine, arthritis, tuberculosis and allergic conditions; diseases of the nervous system, and surgical conditions of the extremities. Cases or groups of cases of sufficient interest will be studied in greater detail in the capillary laboratory already established at this institution.

THE annual general meeting of the Association for the Promotion of Cooperation between Scientific and Technical Societies and Institutions within the British Empire was held, according to *Nature*, at Burlington House, London, on December 1. The report, which was adopted, referred to the appeal for a central building in London issued in February of this year to the members of the constituent societies and institutions, in which it was stated that options had been secured for a limited period on a site near Westminster Abbey, and that an estimated sum of £350,000 would be required to defray the cost of the complete building, including the purchase of leases, etc. It was further mentioned that to complete the purchase of the leases it would be necessary to secure £100,000 in cash by June 24, 1931, when the options on the site would expire. A considerable response to the appeal was received, but the sum available by June 24, however, fell considerably short of the amount required in cash, and the Council of Management decided to allow the options on the leases to lapse. The acute financial and industrial conditions prevailing during this year, culminating in the recent crisis, have rendered it necessary for the council to postpone a public appeal until national conditions have improved. Though regretting the consequent delay in proceeding with the central building scheme, the council will not relax its efforts to bring the scheme to fruition at the earliest possible moment.

IN their report to the University of Cambridge on forestry in the university curriculum the General Board states that it has been much concerned about the future of the Department of Forestry. There is practically no future for graduates trained in forestry except in Government Forest Services. Only twenty to twenty-five of these posts are available each year, and there are no fewer than five university schools, including the one at Cambridge, engaged in training candidates for these posts. As a result of investigations the committee of the General Board came to the conclusion that the university would not be justified in maintaining a forestry organization as a recruiting ground for government services, partly because the demand was so small, but even more because they considered that university policy in forestry teaching can not be reconciled with the present official view. They accordingly recommend that the

Department of Forestry be suppressed, examinations in forestry for the ordinary B.A. degree be discontinued after 1934, and examinations for the diploma in forestry cease in October, 1935. The titles of faculties and examinations concerned would be amended where necessary by the deletion of the word "forestry."

THE Acadia National Park, in Maine, which includes a considerable part of the famous Mount Desert Island and about half of Schoodic Peninsula, to the east across Frenchman Bay, is shown on a new map just issued by the United States Geological Survey, Department of the Interior, on a scale of 1 mile to the inch, with the surface forms indicated by contour lines drawn at vertical intervals of 20 feet. Mount Desert is far from a desert: the name given by Champlain, "l'isle des monts deserts," was applied with the original French signification of the word "deserts"—that is, wild and solitary, not devoid of vegetation. The island vegetation is exceptionally vigorous and combines with the rugged beauty of this part of the Maine coast to make a landscape of superb attractions. The national park, the only one on the seashore, includes much of the wildest part of the island. The map shows clearly the remarkable variety of land forms and coastal waters, and on the back of the map is a simply written account of the geology of Mount Desert, from the time when the granitic rock that now forms most of its surface was a plastic molten mass to the events that have modified the surface since the glacial invasion.

A GOLD medal for anthropological research is in future to be awarded annually by the Royal Anthropological Institute for the best research essay written on the application of anthropological methods to the problems of native peoples, particularly those arising from intercourse between native peoples, or between primitive natives and civilized races. The medal, which is to be known as the Wellcome Gold Medal for Anthropological Research, has been provided by Dr. Henry S. Wellcome, and will be bestowed at the annual meetings of the Royal Anthropological Institute, at the recommendation of a special medal committee. The president of the Royal Anthropological Institute will be the chairman of this committee, while of the other members one will be the conservator of the Wellcome Historical Medical Museum, the three remaining persons being nominated, respectively, for a period of three years, by the presidents of the Royal Anthropological Institute, the Royal Empire Society and the African Society. Candidates for the medal may be of any nationality, but the essays must be submitted in English. If unpublished, they are to be submitted, at the discretion of the medal committee, for publication by the Royal Anthropological Institute.

The essays are intended to be of moderate length, and must be delivered in triplicate copies at the office of the Royal Anthropological Institute by the first of January in the year when they are to be considered by the committee. The first award of the medal will be made next year.

THE *Journal* of the American Medical Association reports that the Prince Leopold Institute of Tropical Medicine, recently established at Antwerp, has for its purpose the creation and maintenance of a school of hygiene and of tropical medicine, for the training of colonial physicians and sanitary agents; for the study of all problems pertaining to the etiology and the therapeutics of tropical diseases, and to establish laboratories and clinics as annexes of the school. The courses given in the new institution will be organized in such a manner as to meet the requirements of the curriculum established by the minister of the colonies for physicians in the government service.

THE *London Times* reports that a new development in the scientific investigation of those problems of marine biology the solution of which is of importance to the fishery industry was marked by the formal opening at the University College of Hull of new fishery research laboratories for the department of zoology and oceanography. When the Hull University College was founded a few years ago one main object of the promoters was the establishment of a department of marine biology by which it was hoped to render scientific services to the fishing industries, and the college authorities appointed as head of this department Professor D. C. Hardy, who, after spending some years in the laboratories of the Ministry of Agriculture and Fisheries at Lowestoft, had joined the scientific staff of the *Discovery* and had then recently finished his work with that expedition. At Hull Professor Hardy has extended his earlier work in fishery research, and that it is appreciated by the fishing industry was shown by the presence of Sir John Marsden, president of the British Trawlers' Federation, who opened the new laboratories, and of Mr. H. G. Maurice, Fisheries Secretary of the Ministry of Agriculture and Fisheries. Professor Hardy is now hoping that both the herring and the trawling sides of the British fishery industry will join in forming a small committee to keep in touch with the fishery research work of the college. The basic problems affecting the fishing industry center in plankton, its different varieties, the dif-

ferent kinds of organisms it contains, the study of the different localities in the ocean where these different kinds most exist, the motions to which areas of particular species are subjected by the ocean currents, the kinds of fish that are attracted to or repelled by the different waters, and the ascertainment of the facts which determine the movements of these varying feeding grounds of the different species of fish. The whole study is now pursued on international lines by the scientific men of many countries, who are united in the International Council for the Exploration of the Sea. It is hoped that the work at Hull will fit into and form part of this plan of oceanographic research.

THE regular correspondent of the *Journal* of the American Medical Association reports that a record low death rate and a low infant mortality rate are the two main features of the annual demography bulletin for 1930, which deals with the population and vital statistics of Australia. The infant mortality rate was 47 per thousand; with the exception of the New Zealand rate, this is the lowest in the world. The rate for New Zealand is 34.5. The death rate was 8.59 per thousand of the population. This rate was the lowest ever recorded in Australia and compares most favorably with that of other countries. The principal causes of death were heart disease, 15.6 per cent.; cancer, 11.1 per cent.; tuberculosis, 5.9 per cent.; acute and chronic nephritis, 5.7 per cent., and pneumonia, 3.5 per cent. The maternal mortality rate was 5.29 per thousand children born. At the end of 1930 the population of Australia reached the total of 6,476,032, which represents a growth of 1,064,735 during the last ten years. To this total gain, natural increase contributed 73 per cent. and net migration 27 per cent. The rate of growth during 1930 was 1.81 per cent., and is among the highest rates of increase in the world. The birth rate was 19.93 per thousand of population, the lowest ever recorded. Compared with that of many other countries, the Australian rate is low, but fortunately it is accompanied by a low death rate giving a rate of natural increase which is equaled in few countries. Exnuptial births were 4.62 per cent. of all births registered. The average family per mother in 1930 was 2.92 as against 2.96 in 1929. The density of population, that is, the number of persons to the square mile, in Australia is only 2.18 and varies from 1 person in 100 square miles in the Northern Territory to 20.38 to the square mile in Victoria.

## DISCUSSION

### TWISTING IN LOWER FORMS OF PLANTS

WITHIN recent months a number of notes have been published in *SCIENCE* regarding twisting in the bark

and wood of trees. Various factors have been invoked to account for the twisting, such as sunlight and wind, thus explaining the more frequent occurrence

of twisted trees on the edge of forested areas rather than within them.

The supposed influence of position as related to the sun and to prevailing winds has suggested that if the right twist is more common in the northern hemisphere, as the results would indicate, the left twist should be more common in the southern.

Twisting in vines and their tendrils is familiar to all; the direction of the twist is, I believe, quite constant for any species. Different trophisms have been thought to be the cause, and a frequent experiment is to determine the effect of rotation of the plant in different axes on the twisting.

It may not be known to many that a similar phenomenon has been noted in lower forms of plant life. Boas<sup>1</sup> described and pictured a symmetrical bending of the filaments of a colony of *Oidium lactis* growing on agar. He stated that he has also noted the same symmetrical bending of the hyphae in the case of the molds, *Penicillium brevicaulis* and *Rhizopus nigricans*. He believes the spiral-like growth is widespread among the fungi.

The bending of the threads, consisting of a number of parallel rows of cells, of the bacterium variously known as *Bacillus mycoides* or *Bacillus ramosus*, is a striking example of what seems to be comparable to the twisting in higher plants. This organism, when seeded at one point on the surface of a disc of agar, spreads out uniformly in all directions. The appearance to the eye is that of a tangled mass of threads, the main branches of which bend in a uniform direction. The bending of the threads in the various strains which the writer has isolated is counter clockwise. Strains have been described by European bacteriologists in which the bending is to the right and others are what might be called neutral, the bending being neither to the left nor to the right in an apparent manner. These various forms are thought to be identical in other respects, as determined by the usual methods of the bacteriological laboratory, including the antibody reactions.

The factors, wind, sunlight, etc., which have been invoked to explain the twisting of higher plants, do not enter here. Several have studied the effect of position on the bending and have noted no effects. The writer, following the lead of the botanists, has observed the effect of rotation of the culture during its growth. The constant rotation of the culture on a horizontal axis parallel to the surface of the substratum exerts no influence on the appearance of the growth, nor does rotation on a vertical axis at a right angle to the surface of the substratum, while rotation on an horizontal axis at a right angle to the surface of the substratum causes such a lack of sym-

metry as to be recognizable by observers ignorant of the conditions existing during growth. The distortion is noticeable not only in lack of symmetry but in the breadth of the threads. The distortion is most marked when the rotation is in the same direction as the normal bending of the threads, that is, counter clockwise.

If the bending of the threads of the bacterium is comparable to the twisting of vines and trees, the lower organism offers many opportunities to the student to measure the effect of this and that factor and possibly to discover a more adequate explanation than those yet presented. The writer, for example, is attempting to find what may be the effect of growing the organism in the southern hemisphere through the aid of a friend in Australia.

It is possible to obtain a growth in which the bending is not present, by using a medium which is less firm than the usual agar of the laboratory. Changing the type of growth does not, of course, offer any explanation for the usual bending of the threads in a definite direction. One writer has spoken of biological isomerisms, the three forms of the organism being comparable to the left, right, and inactive compounds as regards polarized light. Variation in the spacial arrangement within the cell may be a common occurrence. It may account for the type of optical activity of the compounds formed by organisms.

E. G. HASTINGS

UNIVERSITY OF WISCONSIN

#### METEORITES IN SEDIMENTARY ROCKS?

FOR many years I have searched for meteorites or meteoritic material in sedimentary rocks. About fifteen years ago, one of my students found a meteorite in a bed of gypsum in western Oklahoma. At first, it was thought that the occurrence represented a fall at the time of the deposition of the gypsum, which is Permian in age. A careful study of the occurrence of the meteorite, however, proved that it was evidently recent. I have interviewed the late Dr. G. P. Merrill, of the U. S. National Museum, and Dr. G. T. Prior, of the British National History Museum, both well-known students of meteorites, and neither man knew of a single occurrence of a meteorite in sedimentary rocks. Dr. Prior knew of a meteorite that was found in recent stream gravels but of none occurring in sediments of past geologic periods.

This letter is a petition for any information indicating that meteorites do occur in the sediments. Dr. Merrill was of the opinion that we should not expect to find them in the sediments because they would decompose before they could be buried. Although we may admit that the iron-nickel meteorites might

<sup>1</sup> Zentb. f. Bakt., II, 49, 412. 1918.

undergo rapid oxidation under the conditions of weathering on the land surface and the stony meteorites at a slower pace, if a meteorite of any type fell in a sea in which muds or limestones were accumulating, why should it not be buried in these sediments? We know that many of the minerals of the stony meteorites are similar to those of the terrestrial rocks and that the minerals of the latter may be buried without undergoing decomposition. We find arkosic rocks and graywackes (which contain minerals that under normal weathering conditions decompose entirely) that have been buried and constitute integral parts of sedimentary rocks.

An iron meteorite falling in sea water would be rapidly attacked (unless quickly buried) and the exterior converted into iron oxides which would protect the inner portion, in some degree at least, from complete alteration. Even if such a meteorite were completely altered to iron oxides, these should remain as a type of pseudomorph of the original meteorite. Unless the nickel which normally occurs in iron meteorites were all removed during the oxidation, its presence in the resulting ferruginous mass might be taken as evidence of the meteoritic origin of the mass. I have never found any material which suggested that it was of this origin or which seemed to merit being tested for nickel. It is equally difficult to believe that a stony meteorite, falling in a soft mud or calcareous ooze would not be buried before decomposition took place.

The presence of meteoric material in deep-sea muds has little real bearing on the question, as this material may be recent. It is in the possible occurrence of meteorites in the ancient sediments that I am interested. I will appreciate any information any one may have regarding this interesting quest.

W. A. TARR

UNIVERSITY OF MISSOURI

#### POSSIBLE RELATION OF AGE AT SEXUAL MATURITY IN BIRDS TO DAILY PERIOD, INTENSITY AND WAVE-LENGTH OF LIGHT

In a recent paper, Riddle<sup>1</sup> shows that, in pigeons and doves, age at first sexual maturity is hastened if the bird reaches an age of 4 to 5 months between February 1 and July 31, and is delayed if this age is reached in autumn. The delay may reach 36 per cent. in pigeons and 52 per cent. in doves. This is brought about by endocrine conditions (thyroid and perhaps pituitary) connected with this part of the year. Earlier studies had shown that the season of accelerated sexual maturity is also the season when,

<sup>1</sup> O. Riddle, "Studies on the Physiology of Reproduction in Birds. XXIX. Season of Origin as a Determiner of Age at which Birds Become Sexually Mature." *Am. Jour. Physiol.*, 97 (4): 581-587, 1931.

even in mature birds, thyroid size and activity is decreasing. He found a seasonal factor in practically all aspects of sex and reproduction studied in doves and pigeons.

Rowan<sup>2</sup> shows that the seasonal changes of the gonads and occurrence of sexual maturity in the junco, with a single seasonal sexual cycle, is conditioned by length of daily period of illumination. He thinks the change of light period does not act *per se* but by prolonging or shortening the daily periods of muscular exercise. He has since come to the conclusion that this relation holds also for the crow in Alberta, Canada.<sup>3</sup> He altered the sexual cycle in the junco and crow by artificially lengthening or shortening the daily period of illumination for the birds. This is related to the changes of the sex glands and through them or with them to migration in these birds.

The writer<sup>4,5</sup> has reported the close relation of attainment of sexual maturity in the European starling in Hartford, Connecticut, (with single seasonal cycle) to the daily period of illumination, whether of natural or artificial light. This is not caused by changes of periods of muscular exercise in the starling as claimed for the junco by Rowan. However, increased periods of muscular work were found to prolong the refractory period before light-induced testis changes appear and perhaps to increase the rate of acceleration of changes once begun as the result of light change.

In a later study,<sup>6</sup> it is shown that light intensity is a factor in the induction of sexual maturity in the starling, when the periods of daily light are equal. Up to a certain light intensity, rate of acceleration of germ-cell activity, induced by added light treatments of equal duration, varies with the light intensity. Increase of daily period of illumination, even with low intensity of added electric light will induce sexual maturity in both first-year birds and those over a year old and sexually mature at least once before. This may be brought about even in midwinter at midwinter temperature. Sexual ma-

<sup>2</sup> Wm. Rowan, "Experiments on Bird Migration. I. Manipulation of the Reproductive Cycle: Seasonal Histological Changes in the Gonads," *Proc. Boston Soc. Nat. Hist.*, 39: 151-208, 1931. See list there.

<sup>3</sup> Article in *New York Times*, July 21, 1931, "To Use 1,000 Crows in Evolution Tests, etc."

<sup>4</sup> T. H. Bissonnette, "Studies on the Sexual Cycle in Birds. I. Sexual Maturity, Its Modification and Possible Control in the European Starling (*Sturnus vulgaris*): a General Statement," *Am. Jour. Anat.*, 45: 289-305, 1930.

<sup>5</sup> T. H. Bissonnette, "Studies on the Sexual Cycle in Birds. IV. Experimental Modification of the Sexual Cycle in Males of the European Starling (*Sturnus vulgaris*) by Changes in the Daily Period of Illumination and of Muscular Work," *J. E. Z.*, 58: 281-319, 1931a.

<sup>6</sup> T. H. Bissonnette, "Studies on the Sexual Cycle in Birds. V. Effects of Light of Different Intensities upon the Testis Activity of the European Starling (*Sturnus vulgaris*)," *Phys. Zool.* in press, 1931b.

turity occurs in nature only in April, May and very early June.

In a further study,<sup>7</sup> it was found that the degree of effectiveness of the light and the character of its effect depend on the wave-length of the light used, when the luminous intensity is the same in artificial additions to daily sunlight period inside a room behind window glass. Red light, at relatively low intensity of illumination, induces sexual maturity in as short time as 23 days in midwinter, while green at the same intensity does not induce it at all, but inhibits it, in males at least. This occurs in juvenile birds of the previous summer's broods as well as in older birds.

It is known that spring sunshine is relatively rich in long red wave-lengths and poorer in the shorter wave-lengths of light, while summer and autumn sunlight is richer in shorter wave-lengths in comparison. So the same intensity of sunlight in spring is more stimulating to sexual maturity than in autumn or summer, for it contains relatively more of the stimulating red rays.

In view of all the above findings, it is suggested that Riddle's results point to a conditioning of the age at first sexual maturity in doves and pigeons, which have polyoestrous cycles, as well as in juncos, crows and starlings, with single yearly sexual activity, by the action of increasing or decreasing effectiveness of daily light periods. This effectiveness depends on length of period, intensity and wave-length of illumination per day. This may be affected by the above mentioned changes of the relative amounts of longer, stimulating rays and shorter, inhibitory wave-lengths of light incident to the season and height of the sun above the southern horizon. This is probably correlated with the endocrine functions of the thyroid and anterior pituitary glands as Riddle suggests.

The following scheme is suggested to describe the relation of age at first sexual maturity to the endocrine function and to the acceleration or delay of sexual development in birds on the basis of Riddle's, Rowan's and Bissonnette's experiments:

- E = basal endocrine stimulus to sexual development of each race, or bird.  
 -L = action of shortening days with decreasing intensity and less long-wave light.  
 +L = action of lengthening days with increasing intensity and relatively more long-wave light.  
 R = Rate of development to sexual maturity in birds nearing the 4-5 month age at any time.  
 A = Age at first sexual maturity.  
 For July to January,  $R = E - L$ .  
 For February to June,  $R = E + L$ .

<sup>7</sup> T. H. Bissonnette, "Studies on the Sexual Cycle in Birds. VI. Effects of White, Green and Red Lights of Equal Luminous Intensity on the Testis Activity of the European Starling (*Sturnus vulgaris*)," *Physiol. Zool.*, in press, 1932.

$$A = \frac{K}{R} = \frac{K}{E \pm L}$$

where K is a constant for the breed of bird. Birds mature early if they reach 4 to 5 months of age when +L is effective, in February to June, and late if -L is effective, in July to January.

It would be interesting to test the correctness of this suggestion by treating young doves or pigeons, of known breeding behavior, with various types of daily light period as has been done with the starlings. If it is valid, the age at maturity in these birds can be modified at will, irrespective of season.

T. H. BISSONNETTE

MARINE BIOLOGICAL LABORATORY,  
WOODS HOLE, MASSACHUSETTS

### "ENTAMOEBA" PHALLUSIAE

MACKINNON and Rae describe "*Entamoeba*" *phallusiae* in the June number of the *Journal of the Marine Biological Association of the United Kingdom*. This note is written merely to call attention to the slight doubt whether the form described is an *Entamoeba*. *Entamoeba* has a centronucleus (Boveri's very convenient term) containing a centrosome with a centriole, as have also many small amoebae, *e. g.*, most soil amoebae. From the figures and description of "*Entamoeba*" *phallusiae* one is in doubt as to the presence of an intranuclear centrosome, Fig. 3, A, B, and C suggesting, but not showing it.

The parasitic habit is not enough to determine that a species is an *Entamoeba* rather than an *Amoeba*, though it makes it probable that it is so. The chief distinction between the two genera is in the presence or absence of a centronucleus. Species of the true genus *Amoeba* have not been found to contain a centrosome, with centriole, in the nucleus. Many minute soil amoebae are morphologically *Entamoebae* and should be so recognized in spite of the absence of the parasitic habit. Habitat is hardly a proper determinative feature for generic diagnosis.

*Amoeba*, of course, is clearly a valid genus (See Mast and Johnson, *Archiv f. Protistenkunde*, 75, 1, 1931). Many so-called genera both of *Amoebae* and of forms with centronuclei when treated as subgenera give as good or a better idea of probable relationship.

MAYNARD M. METCALF

THE JOHNS HOPKINS UNIVERSITY,  
OCTOBER 29, 1931

### NATURALLY DEPOSITED EGGS OF THE MYXINOIDEA (HYPEROTRETIA)

EVER since J. Müller (1843) described the genital system of the myxinoids, many interested zoologists in Europe and America have attempted in vain to find the naturally deposited eggs of these eels. In

1896 a Chinese fisherman, who had accidentally brought to the surface on trawl lines some eggs of *Bdellostoma stouti* near Monterey, California, collected a number of the eggs for G. C. Price, Bashford Dean and others. The fisherman would reveal to no one how or where he secured the eggs, and his secret died with him.

Through the courtesy of the Boston Society of Natural History, the Committee on the Permanent Science Fund of the American Academy of Arts and Sciences, the Bashford Dean Memorial Committee of the American Museum of Natural History and the National Research Council, I have been able to search during several summers for the naturally deposited eggs of *Myxine* and *Bdellostoma*. In the summer of 1930 I succeeded in collecting between five and six hundred naturally deposited eggs of *Bdellostoma stouti* near Monterey, California; at least 130 of the eggs had embryos.

No one has succeeded in finding naturally deposited eggs of *Myxine*, and the many attempts to obtain fertilized eggs by keeping the eels in captivity have failed. While fishing during the months of July, August and September, 1931, near the mouth of Frenchman Bay, five miles from Bar Harbor, Maine, I succeeded in collecting about fifty naturally deposited eggs of *Myxine glutinosa*. The eggs were brought up from the bottom of the ocean in from thirty to thirty-five fathoms of water.

My experience in searching for the eggs of both *Bdellostoma* and *Myxine* leads me to the conclusion that the eels do not migrate, and that they deposit

their eggs at all seasons of the year in certain favorable spots very near their feeding grounds.

J. LEROY CONEL

BOSTON UNIVERSITY SCHOOL OF  
MEDICINE

### SEDIMENTATION AND SEDIMENTOLOGY

"SEDIMENTATION," as generally understood, is that branch of geology which deals with the processes of sedimentation and the origin of the sedimentary rocks.

Webster's New International Dictionary for year 1929 says: "Sedimentation is an act or process of depositing sediments."

The current use of the term in geology is ambiguous and in some cases incorrect. Geologists in general have not taken very kindly to the term "sedimentationists," but resort to cumbersome phrases such as "petrologists interested in sedimentary rocks" or "petrologists working on sedimentary deposits." It is questionable if the use of the phrases "sedimentary petrology," and "sedimentary petrologist" side by side with "sedimentary deposists," i. e., deposits formed by sedimentation, is correct.

*Sedimentology* is here suggested as a term for the subject taught, retaining *sedimentation* for the act or process of deposition. The new term and its derivatives *sedimentologist*, *sedimentologic* and *sedimentological*, will tend toward clearness. *Sedimentology* and *sedimentation* have their analogies in *glaciology* and *glaciation*, respectively.

HAKON WADELL

DEPARTMENT OF GEOLOGY  
UNIVERSITY OF CHICAGO

## REPORTS

### SCIENCE BOOKLETS FROM THE AMERICAN ASSOCIATION

IN 1929, a suggestion to the council of the American Association for the Advancement of Science brought about the appointment of a special committee on the preparation of a series of science booklets for distribution to the American public.

This committee was to arrange for selecting the most appropriate books on each of twenty-seven subjects deemed most important in the field of pure science, and to secure the cooperation and collaboration of numerous scientists, librarians and others familiar with these books. The committee was also to find funds with which to pay for the printing of the lists when ready.

In this series the applications of science to industry and invention are not developed to any great extent; it is hoped that lists on the industrial sciences, especially on the applications of the physical sciences, may be worked up into similar lists by some other national body.

In the fall of 1929, tentative title lists, containing a considerable surplus of titles beyond the twenty-five which had been set as the maximum number for any one list, were mailed to a large number of prominent scientists and to some of the larger public libraries and museums, asking for votes on the most suitable books and cancellation of the least desirable titles, as well as for editorial suggestions that would make the lists most useful for the purpose.

This purpose was very carefully defined; it appears on each of the printed lists:

These lists have a three-fold object: (1) To select and describe a few authentic and especially interesting books acceptable to the "general reader"; (2) to supplement these with several introductory treatises in understandable style; (3) to suggest a group of text-books for more advanced study by ambitious amateurs, or persons studying by themselves. Books written in America, recent and not out of print, nor too expensive, have been favored, but there are numerous exceptions. The books can generally be borrowed from libraries, or bought from bookstores. Libraries which lack these titles may be able to borrow them

from the state library commission, or some other large library, by the inter-library loan system.

The routine work in handling the correspondence, in gathering, sorting, challenging and preparing titles was handled largely on the personal time, out-of-hours, of the librarian and one member of the staff of the Enoch Pratt Free Library of Baltimore, with some clerical help from the Library, where the latter work was justified on the basis of the advantages which it gave to the scientific department of the library in reorganizing and understanding its own collections. Valuable help was given by Miss Jeanette Lucas, Assistant in the Library of the American Museum of Natural History, Mr. Leslie T. Little, of the Waltham Public Library, and by Mr. Gilbert Ward, Head of the Science Department of the Cleveland Public Library.

In February, 1931, a semi-final mimeographed list was sent out again to over 400 names. The 300 new returns made it fairly easy to decide on the final lists. Even here, however, the fresh arrival of newly published books made some complications, and the experience of some libraries with the demands of their readers, warranted challenging some of the decisions from the view-point of the public. In many cases, special letters were sent back and forth to the cooperators in discussing points raised. Where a decision was difficult, special memoranda were prepared and sent to a new group for additional votes on which to base final decisions.

What should be done, for example, when one of the officers of a national group marks one nature handbook as "the only one worth consideration," while several colleagues cross it off altogether, and crosses off a study guide which another professor considers good enough to star? The votes usually settled such questions.

If anything, the lists are solid and scientific, rather than "popular." Many books actively advertised and sold are not here, while numerous advanced books are included. In general, only books of scientific accuracy are included, but when two of the best known scientific explorers and writers of the present day are voted down by a few scientists for "trying to be too popular" (with considerable success), while their books are well reviewed by other scientists, it is evident that there is a feeling against books written by men of scientific training and standing who are able to hold the limelight too prominently. Some authorities do not favor books written by those who are not full-fledged scientists, even though able and on the whole accurate.

Nearly 400 individuals had a part in this work, nearly 2,000 books were carefully examined, more than 2,000 reviews consulted, and it is felt that the final lists are worthy of being published for general

use by individual readers, and as buying lists for libraries and schools. The Committee extends its hearty thanks to all who have so generously cooperated.

The descriptive notes were prepared with the readers in mind. Chief reliance was placed on the *Book Review Digest*, and the various reviews in scientific and popular magazines to which it is the key. In addition, however, such excellent annotated and selected lists as the A. L. A. Catalog, A. L. A. Booklist, Standard Catalog, Scientific Book of the Month Club Review, were used, and the English magazine *Science Progress*, (of which unfortunately there is no American counterpart). *The Scientific American*, the *Science News-Letter* and numerous special American scientific magazines were carefully scanned. In preparing the final notes, no less than a dozen sources of critical comment and description were in many instances at hand. The full entry, as to edition, pagination, publisher and price is given in each list.

In the summer of 1930, the Carnegie Corporation of New York generously made a grant of \$4,000 to the American Association for the Advancement of Science to meet the expense of printing approximately 40,000 copies of each of these lists, so that they might be distributed free under careful restrictions. In November, 1931, the manuscript was completed on the "Teaching of Science," a subject which was suggested after the main project had been outlined.

The lists, in six-page folder form, the size of a large business envelope, were distributed during November, 1931 (from the association office at Washington), a certain number being sent free to public libraries according to population. Other consignments will be sent to certain universities and museums. Beyond this first distribution, additional copies will be supplied by the American Association for the Advancement of Science from its Washington headquarters, Smithsonian Institution Building, at the cost of additional printing (one cent apiece in quantities of ten and over, of one kind). Individual copies will be sent to readers, for a 5c stamp to cover the cost of handling, one complete set for 30 cents. The lists cover the following subjects: "Science Today" (General); "History of Science"; "Exploring for Science"; "Mathematics"; "Astronomy"; "Geology"; "Meteorology"; "Physics"; "Chemistry"; "Microscope"; "Biology"; "Bacteriology"; "Botany"; "Wild Flowers"; "Ferns, Mosses and Fungi"; "Trees and Shrubs"; "Zoology"; "Animals"; "Birds"; "Insects"; "The Sea and the Shore"; "Inland Waters"; "Fishes and Reptiles"; "Paleontology"; "Evolution and Heredity"; "Anthropology and Ethnology"; "Teaching of Science." Allowing for the occurrence of some titles in more than one list, there are 539 dif-

ferent titles in the entire series, including some books published as late as June, 1931.

The Committee on Booklists consists of Dean Edward W. Berry, paleontologist, Johns Hopkins University; Dr. Paul R. Heyl, physicist, U. S. Bureau of Standards; Dr. Burton E. Livingston, professor of plant physiology and forest ecology, Johns Hopkins University, and General Secretary, A. A. A. S., and Joseph L. Wheeler, public librarian, Baltimore, chairman.

This project has made it clear that more carefully and interestingly written American books for the public are needed in many fields of science. On such subjects as general and special biology, ethnology, light, atomic and quantum physics and relativity, geology, microscopy and many other subjects, there is serious need for systematic, illustrated works, not necessarily brief "appetizers" at one extreme, nor at the other, the conventional text-book. As to good, attractive text-books, great progress has been made in the last five years. We do, however, need books that have more of the broad outlook, imaginative power and literary background and style which characterize some of the work of our English brethren, such as the recent volumes on biology by Wells and Huxley and by Thomson and Geddes, Gregory's "Discovery," or Singer's "Short History of Biology," and Seward's "Plant Life Through the Ages," not to mention the well-known works of Jeans and Edding-

ton. We have already such worth-while examples as Fairchild's "Exploring for Plants," Allen's "Book of Bird Life," Slosson's books, Cushing's "Osler," Shapley's "Flights from Chaos." These books combine through knowledge and accuracy with some literary style and a sustained vigor; they make a presentation suitable to interest the great army of prospective readers beyond the A-B-C stage. Two 1931 American books which set a high mark are Johnson's "Taxonomy of the Flowering Plants" and Crowder's "Between the Tides."

One definite lack is that of an adequate, interesting history of American science, emphasizing the biographical side. A letter from J. Porter, of Vancouver, well worth reading, appears in the *Literary Supplement* to the *London Times* of August 6, on the lack of American scientific biography. One paragraph says:

... America has not been so fortunate. A generation of the giant workers in geology has passed almost unmarked. Even such interesting characters as Powell and Clarence King and Grove Karl Gilbert have failed to receive adequate notice from writers of biography. In the field of physics a small library has grown up around Franklin, but Joseph Henry and H. A. Rowland have little chance of stimulating future generations.

JOSEPH L. WHEELER

ENOCH PRATT FREE LIBRARY,  
BALTIMORE

## SCIENTIFIC APPARATUS AND LABORATORY METHODS

### CULTURAL AND INOCULATION METHODS WITH *TILLETIA* SPECIES

IN *SCIENCE* for October 2, p. 341, E. W. Bodine describes a "Double Plate Method used for Culturing *Tilletia levis*," in which I was much interested and to which I might add some further observations.

A similar inverted-plate method was used by Kluyver and van Niel<sup>1</sup> in making cultures of species of *Sporobolomyces* in 1924-1925. This procedure was possible because the basidiospores of this basidiomycetous yeast are shot away from their sterigmata.

The discovery by Buller and Vanterpool,<sup>2</sup> in 1925, that the so-called secondary conidia of *Tilletia tritici* are violently discharged from their sterigmata revealed a phenomenon which finds application in both cultural and inoculation technique with species of *Tilletia*. Since 1925, I have used the double-plate or inverted-plate method as described by E. W.

<sup>1</sup> A. J. Kluyver and C. B. van Niel, "Über Spiegelbilder erzeugende Hefenarten und die neue Hefengattung *Sporobolomyces*." *Centralb. f. Bakteriologie*, Abt. 2, Bd. 63, pp. 1-20, 1924-1925.

<sup>2</sup> A. H. R. Buller and T. C. Vanterpool, "Violent Spore-discharge in *Tilletia tritici*." *Nature* 116: 934-935, 1925.

Bodine, or modifications thereof, in culturing species of *Tilletia* other than *tritici* and *levis*. *Tilletia horrida*, *T. holci*, and *T. asperifolia* were found to discharge their secondary conidia in a manner similar to that described for *T. tritici* and *T. levis*, and therefore could be readily cultured by the inverted-plate method. Some investigators have experienced difficulty in germinating the chlamydospores of *T. horrida* and obtaining cultures free from contamination; but by using the inverted-plate method pure cultures of *T. horrida* can be obtained quite readily.

By this method monosporous cultures of secondary conidia can be secured and crossing or hybridization experiments conducted with a fair amount of facility.

Further, the method has also found application in the multisporous inoculation of germinating wheat seedlings by inverting a vigorously growing culture of *T. tritici* or *T. levis* and allowing secondary conidia to "rain down" on the seedlings during the first two or three days of germination. A temperature of 10° to 14°C., and probably darkness also, favored infection. After inoculation, the seedlings were carefully potted and brought to maturity, when a large per-

centage were found to have developed bunted heads. Doubtless, other species of *Tilletia* discharge their secondary conidia violently and will therefore yield to the methods described above.

T. C. VANTERPOOL

LABORATORY OF PLANT PATHOLOGY,  
UNIVERSITY OF SASKATCHEWAN,  
SASKATOON, CANADA

### A THERMOPHIL NITRITE FORMER

AN investigation of the thermophil bacteria of pine woods soils in North Carolina was undertaken as a part of the requirements of the Ph.D. degree at Ohio State University. A thermophil nitrite former was among the organisms studied. Enrichment cultures in inorganic salt solution were made. From these, single cells were isolated with a Barber pipette. In all experimental work done with this organism cultures grown from single cells were used. A brief description of the organism follows.

The organism was found to be an obligate thermophil with an optimum temperature at 55°-60° C. and a minimum at 40° C. It was not killed after eight hours at 100° C. nor after forty-five minutes under sixteen pounds pressure at a temperature of 120° C. in the autoclave but was killed after sixty minutes. It was found also to be an obligate aerobe.

Morphologically, it was a large, motile, spore-bearing rod found singly and in chains. The spores were terminal and exceeded the vegetative rod in diameter. The flagella were peritrichic in arrangement. When it was stained with Gram's stain, three forms were noted, a large Gram positive rod, both sporulating and vegetative, which varied in size from 3.8 to 8 micra in length and 1 to 2 micra in width; a more slender Gram negative form, also sporulating and vegetative, which varied from 3.5 to 7 micra in length and .5 to 1 micron in width; also a transitional form having a Gram negative core on which were Gram positive fragments in the form of bars and granules. From experimental evidence these were found to be different ages of the same organism. The Gram positive were young, the negative old, and the granular middle aged.

The colonies appeared as minute white dots with dense centers, when grown on mineral salt agar plates.

When incubated at 55° C., as all cultures were, the organism could oxidize ammonium salts to nitrite in amounts ranging from one to five parts of nitrite nitrogen per million. This oxidation was most active in a pH of 9.4, very slight at pH 6.3 and ceased at pH 4.8.

It grew on all ordinary organic media, but as a result its oxidizing power was retarded upon re inoculation into mineral salt media, except in the case of potato.

When dextrose was added to the mineral salt medium, concentrations of 2 per cent. and 1 per cent. completely inhibited nitrite formation, .5 per cent. and .25 per cent. retarded and 0.1 per cent. had no detrimental effect.

Peptone, 1 per cent., in mineral salt medium temporarily checked nitrite formation, then active oxidation followed.

Free CO<sub>2</sub> from the air was necessary as the source of carbon. However that from the carbonate in the medium was sufficient to support a very slight oxidation.

Ammonium salts were used as a source of energy by the organism whenever available, except in one instance, when starch was added to the mineral salt medium.

Since this organism was in all the surface layers of soil tested in both North Carolina and Florida and formed nitrites between 55°-60° C., which is contrary to all findings reported, it is evidently a *new genus* and a *new species*. Considering this fact it seemed advisable to suggest a name. The name is *Nitrosobacillus thermophilus* Campbell (*Gen. et. sp. nov.*).

EVA GALBREATH CAMPBELL

GUILFORD COLLEGE

### MUSEUM TAGS OF CHEMICAL PROOF PAPER

A RECURRING problem in museum technique is offered by the necessity of numbering specimens preserved in alcohol, formalin, or other liquid. The use of metal tags for this purpose has been general, pure tin being by far the best material available. Metal tags are, however, subject to corrosion in formalin solutions or even in alcohol to which formalin specimens have been transferred. There is some difficulty in securing tin of uniformly pure composition, and even a slight impurity may greatly activate the process of corrosion.

The paper known as Dennison's fiber-proof paper, manufactured by the Dennison Manufacturing Company, Framingham, Massachusetts, was devised especially as a chemical-proof paper for laundry tags. I assume it to be a paper impregnated with albumin, which is subsequently hardened by treatment with formaldehyde. This paper comes in 20" x 24" sheets, somewhat variable in thickness. The lot now in use at Field Museum of Natural History is .346 mm thick. This paper does not soften in water, alcohol or formalin solution.

The 20" x 24" sheets, in our practice, are cut into 3" strips. These are printed with rules set 1/4" apart on one side and the initials F.M.N.H. set exactly between the rules, on the other. Numbers are then stamped *into* the paper, to a depth of about half the thickness of the stock, by means of an automatic

numbering machine, such as the one manufactured by W. A. Force and Company, Chicago. The printed rules serve as guides, so that the finished tag measures  $\frac{1}{4}'' \times \frac{7}{8}''$ . These impressed numbers are then inked by hand with Higgins waterproof drawing ink, to increase the legibility of the numbers, and dried. The numbering machine perforates the strip opposite each number, and the numbered strips next have the strings attached. The individual tags are then cut from this strip as wanted.

The late Dr. Carl H. Eigenmann seems to have been the first to use this special paper for numbering museum specimens. Before deciding on its use in the Field Museum, Mr. Alfred C. Weed subjected

sample tags to severe tests, such as boiling and shaking with stones; it was adopted by Mr. Weed and myself for the collections in our charge in 1922. It has since been adopted by the Museum of Comparative Zoology, the Museum of Vertebrate Zoology of the University of California, and the Museum of Zoology of the University of Oklahoma. No disadvantage has appeared during the nine years of our experience with this material.

The small, light, legible tags are of course especially suitable for small mammal skulls, to which they may remain attached while boiling.

KARL P. SCHMIDT

FIELD MUSEUM OF NATURAL HISTORY

## SPECIAL ARTICLES

### THE DISTRIBUTION OF EXTRA-GALACTIC NEBULAE

THE paper gives the results of an analysis of counts of nebulae on E-40 plates made by the writer with the 100-inch and 60-inch reflectors at Mount Wilson. About 20,000 nebulae were counted on 900 plates. Six hundred of the plates represent hour exposures on selected areas uniformly distributed in galactic coordinates over three-fourths of the sky (north of Dec.  $-30^\circ$ ). The remaining 300 plates, with exposures ranging from 20 min. to 3 hours, were for the most part centered on individual objects.

#### REDUCTIONS

The counts were reduced to a homogeneous system by corrections for quality (the better the definition the greater the number of small nebulae which could be distinguished from stars, etc.) and later for zenith distance. Plates with the two telescopes were first analyzed independently but were later combined by applying a mean factor to the 60-inch results. Corrections were also derived for reducing the actual counts to the number of nebulae per square degree (coma factor and area factor). These, however, were not used in the intercomparison of plates. Tabulation of the data and the detailed analysis will appear in a contribution from the Mt. Wilson observatory.

#### RESULTS

Results of the analysis are as follows:

(A) No nebulae are found in very low galactic latitudes. The "zone of avoidance" is irregular and sinuous, the width ranging from  $10^\circ$  to  $40^\circ$ . It appears to represent the distribution of known obscuring clouds—a relatively narrow belt symmetrical to the galactic plane from which run out the great

clouds in Taurus, Cassiopeia, Ophiuchus, etc. The inclined belt of bright B stars and diffuse nebulosity, reaching its highest latitudes in Taurus and Ophiuchus, respectively, is a conspicuous feature.

(B) The zone of avoidance is bordered by partial obscuration which extends out to latitudes  $\pm 40^\circ$  in the general direction of the center of the galactic system (longitude  $330^\circ$  to  $340^\circ$ ) but is very limited in the opposite direction except for the known obscuration below the Taurus region (long.  $140^\circ$  lat.  $-35^\circ$  to  $-40^\circ$ , balanced by the obscuring cloud at long.  $330^\circ$  lat.  $+35^\circ$ ).

(C) For latitudes greater than  $\pm 40^\circ$  (and in lower latitude in the direction of the anti-center) the distribution of the nebulae is approximately uniform, with occasional clusters scattered at wide intervals. The mean  $\log N$  for an exposure of one hour with the 100-inch,  $5 \times 7$  plate, definition excellent, zenith distance zero, is 1.74, corresponding to 2.375 for a square degree. This may be compared with  $\log N = 2.036$  per square degree for the 60-inch under similar conditions. The frequency distribution of the counts approximates an error curve with a probable error of the order of 0.15 in  $\log N$  for a single plate. The extreme range is about 1.0 in  $\log N$ , but this includes all accidental errors as well as actual deviations.

(D) In the region of normal distribution and for exposures ranging from 20 min. to 3 hours, the counts are correlated with the exposure times, and the correlation closely approximates that to be expected on the assumption that the nebulae are uniformly distributed in depth (tripling the exposure increases the limit of the plate one magnitude and quadruples the number of nebulae). The scatter about the correlation curve  $\log N = 1.26 \log E - 0.50$  diminishes as the exposures increase. Data from other sources indicate that counts of brighter nebulae are fairly

consistent with this correlation. Appreciable absorption of light in extra-galactic space appears to be inadmissible.

(E) The limiting magnitude for the counts on exposures of one hour with the 100-inch is estimated as 19.8, hence the number of nebulae per square degree is given by the relation

$$\log N_{.d} = 0.6 m_{pg} - 9.5$$

This, combined with the value  $-13.8$  for the mean absolute photographic magnitude of nebulae, leads to a mean density of the order of one nebulae per  $6 \times 10^{16}$  cubic parsecs. A provisional value for the mean mass of nebulae,  $5 \times 10^8$  times the mass of the sun, suggests  $5 \times 10^{-31}$  gm/c.c. as the order of the mean density of nebular material in the observable region of space.

(F) The scanty data available suggest that, in the regions of normal distribution, one cluster of nebulae which would be recognized as such on exposures of one hour, may be expected per 30 square degrees. This frequency is tentative and depends largely upon the criteria selected for defining a cluster.

The distribution of nebulae appears to be approximately uniform out to the limits of the largest telescope available, except in so far as it is affected by partial or complete obscuration by diffuse material within the galactic system. Great clouds of the latter material are known to exist; in fact, the pattern of obscuration along the Milky Way seems to account for many or most of the "star clouds." Evidence from the nebulae concerning a uniformly diffused substratum within our own system is contradictory. In favor of the hypothesis is the fact that, in the general direction of the center, the counts of nebulae are affected out to latitudes  $\pm 40^\circ$ , the occasional late type spirals in low latitudes with abnormally faint surface brightness; and the color-excess exhibited by members of the Perseus cluster of nebulae at lat.  $-13^\circ$ . For these facts a diffuse substratum offers a possible although not a necessary explanation. Against the hypothesis are the approximately normal colors among nebulae in low latitudes and longitudes  $10^\circ$  to  $50^\circ$ , the normal surface brightness of late type spirals in the same region at latitudes as small as  $8^\circ$ , and the fact that for the 8 nebulae within  $20^\circ$  of the galactic plane whose spectra are available, the absolute magnitudes corresponding to distances indicated by the red shifts average brighter than normal. Extensive observations will be required for a definite conclusion. Obscuring clouds are familiar, but a diffuse substratum can be investigated only when the effects of the clouds can be ascertained and eliminated.

EDWIN P. HUBBLE

MT. WILSON OBSERVATORY

## THE HEMOGLOBIN CONTENT OF THE BLOOD OF THE HEN: A STATISTICAL STUDY OF INFLUENCES AND RELATIONS

IN another communication<sup>1</sup> results were presented of a study of the hemoglobin content of the blood of chickens and wild fowls. The method of hemoglobin determination was that of Newcomer. A correction was introduced for at least the greater part of the turbidity of the acid hematin solutions prepared from bird blood for hemoglobin determination by the Newcomer method. The correction formula is

$$C = 0.91U - 1.49,$$

where  $C$  is the corrected reading and  $U$  the uncorrected reading.

Table 1 shows the hemoglobin content of the blood of the hens and the pullets studied.

TABLE 1  
MEAN HEMOGLOBIN CONTENT OF THE BLOOD OF HENS AND PULLETS

	Number of individuals	Uncorrected hemoglobin	Corrected hemoglobin
		gm per 100 cc	gm per 100 cc
White Leghorn hens.....	101	$12.8 \pm 1.0$	$10.2 \pm 0.9$
White Plymouth Rock hens	101	$12.3 \pm 0.8$	$9.8 \pm 0.7$
Rhode Island Red hens.....	102	$11.9 \pm 0.7$	$9.4 \pm 0.7$
White Leghorn pullets.....	101	$11.4 \pm 0.7$	$8.9 \pm 0.7$

The data in this table indicate breed differences, and one purpose of this paper is to present the results of a statistical study made to determine if such differences are significant.

Since data on the age of the birds at the time of making the hemoglobin measurements, on the age at maturity and on the spring egg production were available through the cooperation of the College Poultry Husbandry Department and the dates of making the hemoglobin measurements were known, it was deemed worth while to make a statistical study of the correlation between hemoglobin and these different factors. A presentation of these results is the second purpose of this paper.

For the purposes of this statistical study it is immaterial whether corrected or uncorrected hemoglobin readings be used. The latter readings are used in all instances.

The statistical constants were calculated according to the method given by Wallace and Snedecor.<sup>2</sup>

<sup>1</sup> H. H. Dukes and L. H. Schwarte, *Amer. Jour. Physiol.*, 96: 89-93, 1931.

<sup>2</sup> H. A. Wallace and G. W. Snedecor, "Correlation and Machine Calculation," Official Publication, revised edition. Iowa State College, Ames, Iowa, 1931.

## INFLUENCE OF BREED

The mean hemoglobin content of the blood of the hens of various breeds is shown in Table 1. In Table 2 are shown the mean differences in hemoglobin content by breeds, the probable errors of the mean differences and the ratios of mean differences to probable errors. The mean differences by breed are uncorrected for age and age at maturity. It will be noted that all the differences are statistically significant.

TABLE 2  
DIFFERENCES BY BREED IN THE MEAN HEMOGLOBIN CONTENT OF THE BLOOD OF HENS

	Rhode Island Red hens			White Plymouth Rock hens		
	Mean Hb difference	PE	Ratio	Mean Hb difference	PE	Ratio
	gm per 100 cc			gm per 100 cc		
White Leghorn hens .....	0.9	0.12	7+	0.5	0.12	4+
Rhode Island Red hens .....				0.4	0.11	3+

When the mean differences shown in Table 2 are corrected for age and age at maturity, they are still found to be significant.

## INFLUENCE OF AGE

The hemoglobin content of the blood of chicks is between six and seven gm per 100 cc.<sup>3</sup> Evidently at this period in the life of the chicken age has a considerable influence on the hemoglobin content of the blood.

The mean hemoglobin content of the blood of White Leghorn pullets ranging in age from about four to six months is  $11.4 \pm 0.7$  gm per 100 cc. The mean of White Leghorn hens is  $12.8 \pm 1.0$  gm per 100 cc (Table 1). The difference is  $1.4 \pm 0.12$  gm per 100 cc, which is highly significant. The data also furnish information on the influence of age on the hemoglobin content of the blood of hens. The mean age of all hens was  $658 \pm 10$  days; the mean hemoglobin content of the blood,  $12.3 \pm 0.1$  gm per 100 cc. The correlation between age and hemoglobin was found to be 0.21. The number of hens included in this study is approximately 300. With a number as large as this a correlation coefficient of 0.21 is, according to Fisher's tables,<sup>2</sup> highly significant.

<sup>3</sup> E. B. Hart, C. A. Elvehjem, A. R. Kemmerer and J. G. Halpin, *Poultry Sci.*, 9: 92-101, 1930.

## CORRELATION BETWEEN SEASON AND HEMOGLOBIN CONTENT

There is a wide-spread popular belief that the blood of animals is "thicker" in the winter than in the summer. Furthermore, there is a good deal of evidence<sup>4</sup> tending to show that external heat causes a dilution of the blood. The present data are suggestive in this connection, in that they indicate that with the approach of winter the hemoglobin content of the blood increased significantly. Thus the mean date of the hemoglobin determinations in hens was  $39.4 \pm 0.25$  weeks after January 1, that is, the second week of October; and the correlation between the date of determination (season) and the hemoglobin content of the blood was found to be 0.20.

## CORRELATION BETWEEN AGE AT MATURITY AND HEMOGLOBIN CONTENT

The mean age of all hens at maturity (date of laying first egg) was  $207 \pm 2.0$  days. The correlation between age at maturity and the hemoglobin content of the blood was found to be -0.16, which also is highly significant.

## CORRELATION BETWEEN SPRING EGG PRODUCTION AND HEMOGLOBIN CONTENT

Since spring egg production is a part of yearly egg production, these show a high positive correlation. Therefore a determination of the correlation between spring egg production and the hemoglobin content of the blood would give information about the correlation between the annual egg production and hemoglobin.

The mean production of all hens for the spring of 1929 was  $59 \pm 1.0$  eggs. The correlation between spring egg production and the hemoglobin content of the blood was found to be 0.08, which is not significant.

H. H. DUKES,

L. H. SCHWARTE,

DEPARTMENT OF VETERINARY INVESTIGATION

A. E. BRANDT

DEPARTMENT OF MATHEMATICS,  
IOWA STATE COLLEGE

## BOOKS RECEIVED

- BROTEMARKLE, ROBERT A. *Clinical Psychology*. Pp. xxi + 409. University of Pennsylvania Press.  
JOHNSON, DOUGLAS. *Stream Sculpture on the Atlantic Slope*. Pp. xxii + 142. 21 figures. Columbia University Press. \$3.25.  
MICHALSKI, S., Editor. *Science and Letters in Poland*. Vol. XIV. Pp. x + 404. Institute for the Promotion of Science and Letters in Poland, Warsaw.  
PRATT, CARROLL C. *The Meaning of Music*. Pp. viii + 253. McGraw-Hill. \$2.00.  
ROBERTSON, T. BRAILSFORD. *The Spirit of Research*. Pp. xvi + 210. Preece & Sons, Adelaide.  
<sup>4</sup> H. G. Barbour, *Physiol. Rev.*, 1: 295-326, 1921.